United States
Department of
Agriculture

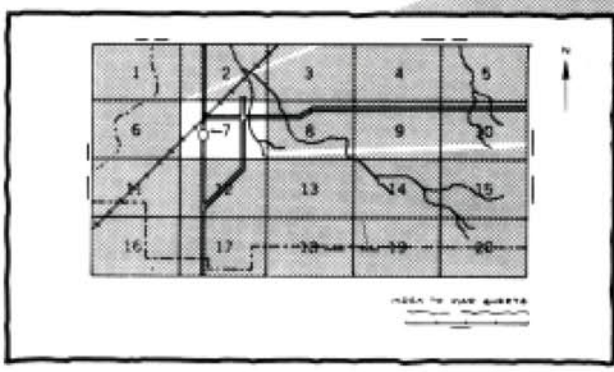
Soil
Conservation
Service

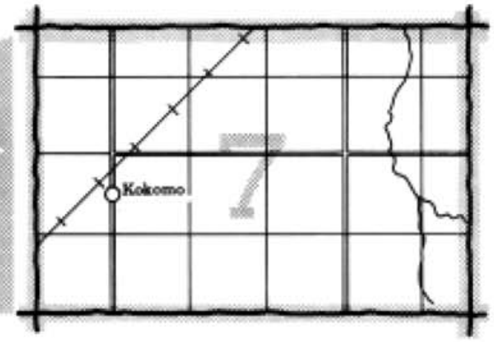
In Cooperation with
United States Department
of Agriculture, Forest
Service; United
States Department of the
Interior, Office of the
High Commissioner, Trust
Territory of the Pacific
Islands; and University of
Hawaii at Manoa, College
of Tropical Agriculture
and Human Resources

Soil Survey of Island of Ponape, Federated States of Micronesia

HOW TO USE

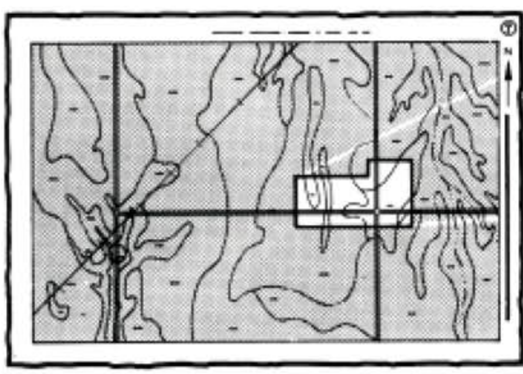
1. Locate your area of interest on the "Index to Map Sheets"

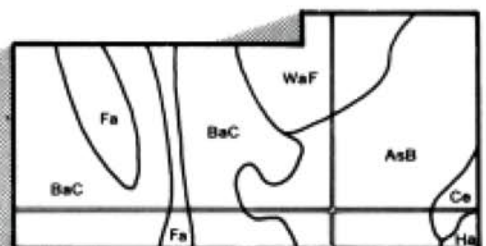




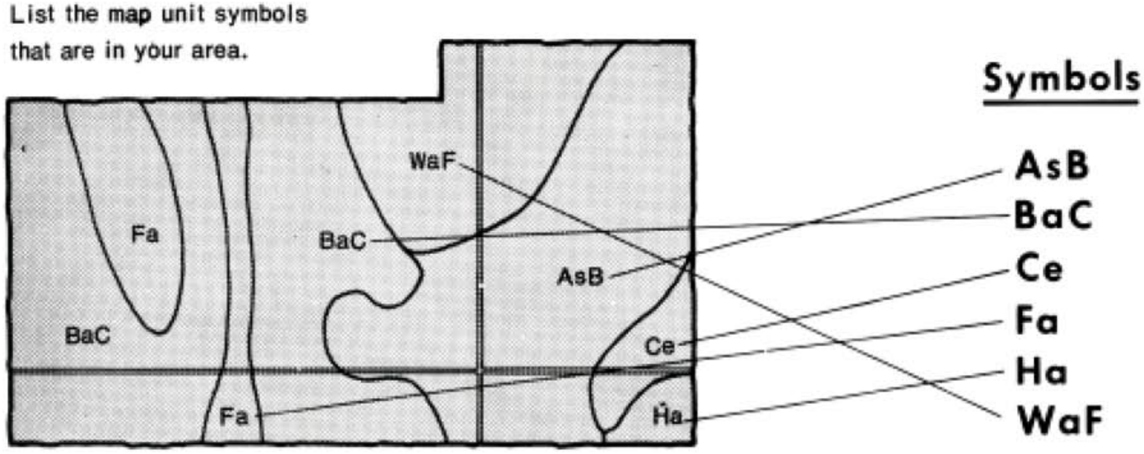
2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.



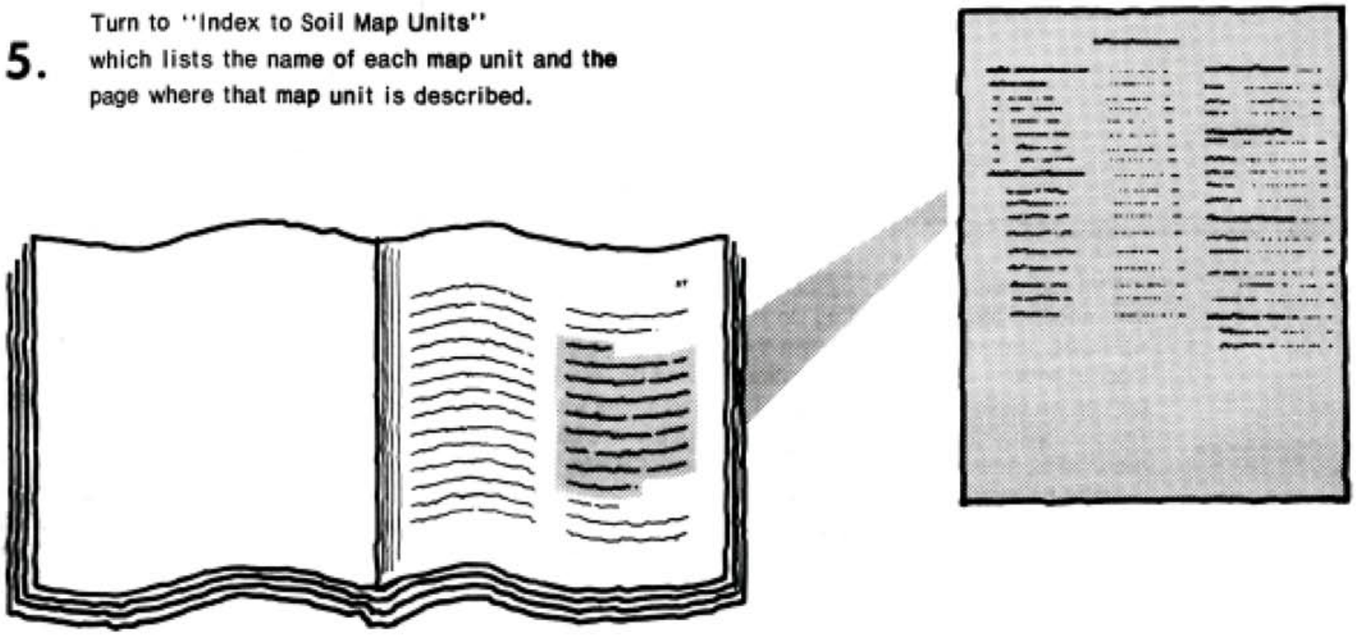


4. List the map unit symbols that are in your area.

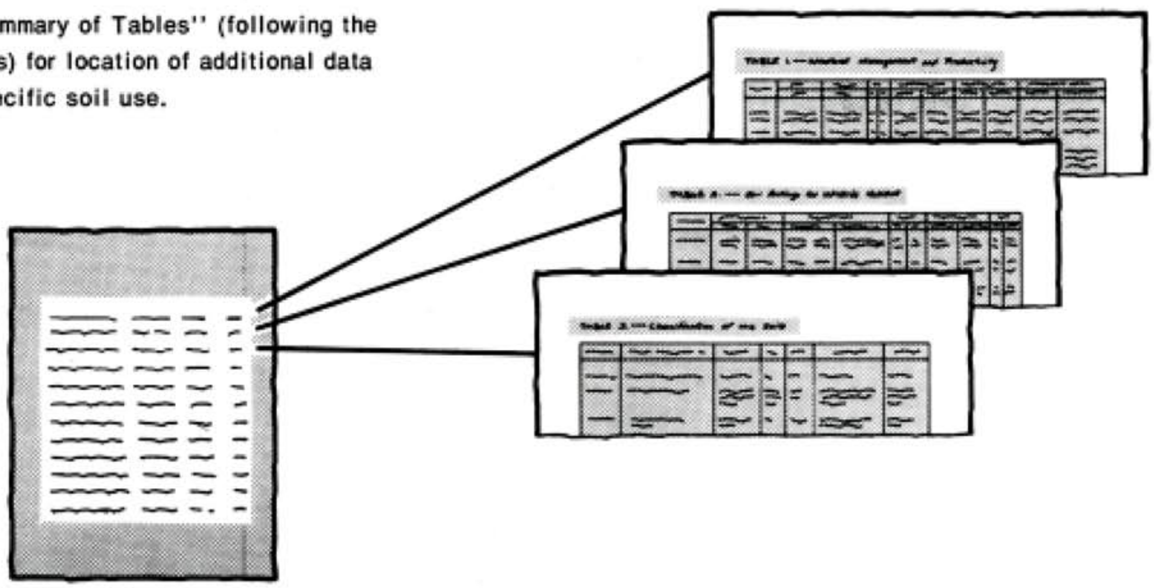


THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was performed in the period 1978-79. Soil names and descriptions were approved in 1980. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1980. This survey was made cooperatively by the Soil Conservation Service and Forest Service; United States Department of the Interior, Office of the High Commissioner, Trust Territory of the Pacific Islands; and the University of Hawaii at Manoa, College of Tropical Agriculture and Human Resources.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

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Issued January 1982

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foreword

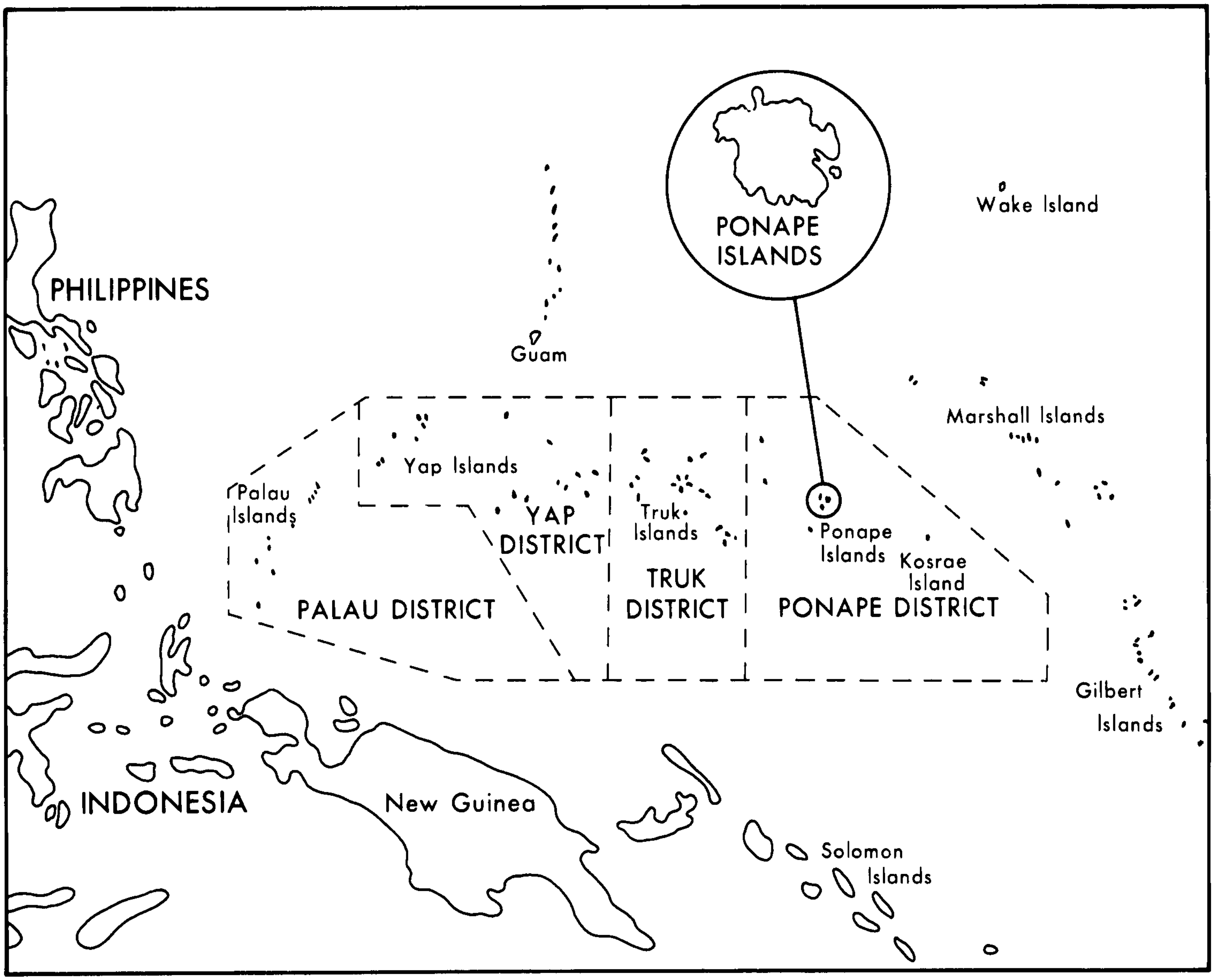
This soil survey contains information that can be used in land-planning programs on the Island of Ponape. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, and builders can use the survey to plan land use, select sites for construction, and identify special practices needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil.

Jack P. Kanalz
Hawaii State Conservationist
Soil Conservation Service



Location of the Island of Ponape, Federated States of Micronesia.

Soil survey of
Island of Ponape, Federated States of Micronesia

By William E. Laird, Soil Conservation Service

Fieldwork by William E. Laird and Christopher W. Smith, Soil Conservation Service, with assistance from Alekko Alexander and Dopi Helgenberger, Ponape State Land Management Department, and Martin Eldridge and Claudio Panuelo, Ponape State Agriculture Department

United States Department of Agriculture, Soil Conservation Service
in cooperation with
United States Department of Agriculture, Forest Service;
United States Department of the Interior, Office of the High Commissioner, Trust Territory of the Pacific Islands;
and University of Hawaii at Manoa, College of Tropical Agriculture and Human Resources

The ISLAND OF PONAPE is a high volcanic island located near the eastern end of the Caroline Island group in the Pacific Ocean. It lies about 750 kilometers north of the equator and about 900 kilometers southeast of Guam. The island is roughly circular and has a diameter of about 23 kilometers. The total area is about 36,462 hectares. The population of Ponape in 1980 was about 20,000.

The island is characterized by high, steep mountains in the interior and is covered with thick, lush vegetation. There are 11 peaks more than 600 meters above sea level and one mountain, Nahnalaud, about 800 meters above sea level (*2*). The steep mountainous areas make up about 61 percent of the island. Surrounding the mountains and extending in some areas to the shoreline are rolling hills, lava flows, and plateaus that make up about 20 percent of the island. The remaining areas are mangrove swamps, which are around the perimeter of the island, and bottom lands, which consist of valley flood plains and coastal plains. The mangrove swamps make up about 14 percent of the island, and the bottom lands about 5 percent.

Subsistence farming and copra and black pepper production are the main farming enterprises on Ponape. The main subsistence crops are bananas, breadfruit, coconuts, sweet potatoes, tapioca, and taro. The local economy is also supported by fishing, handicrafts, tourism, and government jobs.

Soil scientists determined that there are about 18 different kinds of soils on Ponape. The soils in the mountainous areas generally are moderately deep to very deep, are well drained, and commonly are very stony. The use of these soils is limited because of the steepness of slope and stoniness. The nearly level and gently sloping soils generally are moderately deep and moderately well drained. These soils are suited to agricultural development but are limited because of low soil fertility and wetness. The bottom land soils are somewhat poorly drained to very poorly drained. They are poorly suited to most crops because of wetness.

The climate of Ponape is characterized by high rainfall and high temperatures. The average annual rainfall measured at the Ponape weather station in Kolonia is 482 centimeters, and the average annual temperature is

27 degrees C. The rainfall is fairly evenly distributed throughout the year, although the average for January and February is about 30 percent less than the annual monthly average. The rainfall at the higher elevations has not been measured, but it is estimated to be as high as 750 centimeters annually in the mountainous interior areas. The average monthly temperatures do not vary from the annual average by more than 1 degree, and the difference between the average minimum and the average maximum temperatures is less than 8 degrees throughout the year. Temperatures are slightly lower at the higher elevations. Humidity generally is very high throughout the year.

Ponape lies outside the main paths of severe tropical disturbances and typhoons, but every 10 to 20 years a typhoon approaches or crosses the island and causes damage to crops and dwellings. The most destructive typhoon to strike Ponape in recent history was in 1905. It was reported that all coconut trees in production were destroyed and most buildings were damaged (*3*).

how this survey was made

Soil scientists made this survey to learn what soils are in the survey area, where they are, and how they can be used. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; and the kinds of rock. They dug many holes to study soil profiles. A profile is the sequence of natural layers, or horizons, in a soil. It extends from the surface down into the parent material, which has been changed very little by leaching or by plant roots.

The soil scientists recorded the characteristics of the profiles they studied and compared those profiles with others on nearby islands and in more distant places. They classified and named the soils according to nationwide uniform procedures. They drew the boundaries of the soils on aerial photographs. These photographs show trees, buildings, fields, roads, and other details that help in drawing boundaries accurately. The soil maps at the back of this publication were prepared from aerial photographs.

The areas shown on a soil map are called map units. Most map units are made up of one kind of soil. Some are made up of two or more kinds. The map units in this survey area are described under "General soil map units" and "Detailed soil map units."

While a soil survey is in progress, samples of some soils are taken for laboratory measurements and for engineering tests. All soils are field tested to determine their characteristics. Interpretations of those characteristics may be modified during the survey. Data are assembled from other sources, such as test results, records, field experience, and local specialists.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it can be used by farmers, woodland managers, engineers, planners, developers, builders, and others.

general soil map units

The general soil map at the back of this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each map unit on the general soil map is a unique natural landscape. Typically, a map unit consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in other units but in a different pattern.

Some of the soils of minor extent in the map units were not mapped separately in this survey. These soils were mapped separately in the surveys of other islands in the Trust Territory of the Pacific Islands.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one map unit differ from place to place in slope, depth, drainage, and other characteristics that affect management.

The five map units in this survey have been grouped into two general kinds of landscape for broad interpretive purposes. Each of the broad groups and the map units in each group are described in the following pages.

map unit descriptions

soils on bottom lands, on alluvial fans, and in coastal tidal marshes

This group consists of two map units. It makes up about 18 percent of the survey area. The soils in this group are level to gently sloping. The native vegetation is mainly mixed forest, swamp forest, and mangrove forest. Elevation is sea level to 100 meters. The mean annual rainfall is about 400 to 500 centimeters, and the mean annual air temperature is about 27 degrees C.

The soils in this group are very deep and well drained to very poorly drained. They formed in alluvium derived dominantly from basic igneous rock.

This group is used for subsistence farming, woodland, watershed, and wildlife habitat.

1. Nansepsep-Sonahnpil-Inkosr

Very deep, well drained to poorly drained, level to gently sloping soils; on bottom lands and alluvial fans

This map unit is adjacent to drainageways in coastal areas. Slope is 0 to 5 percent. The vegetation on the unit is mainly mixed forest. Elevation is sea level to 100 meters. The mean annual rainfall is about 400 to 500 centimeters, and the mean annual air temperature is about 27 degrees C.

This unit makes up about 4 percent of the survey area. It is about 35 percent Nansepsep soils, 35 percent Sonahnpil soils, and 15 percent Inkosr soils. The remaining 15 percent is components of minor extent.

Nansepsep soils are on bottom lands. These soils are very deep and somewhat poorly drained. They formed in alluvium derived dominantly from basic igneous rock. The soils are loamy throughout. A high water table is at a depth of 50 to 75 centimeters throughout the year.

Sonahnpil soils are on bottom lands and alluvial fans. These soils are very deep and well drained. They formed in alluvium derived dominantly from basic igneous rock. The soils are loamy and stony throughout.

Inkosr soils are on bottom lands. These soils are very deep and poorly drained. They formed in alluvium derived dominantly from basic igneous rock. The soils are loamy throughout. A high water table is at a depth of 15 to 60 centimeters throughout the year.

The soils in this unit are subject to occasional, very brief periods of flooding.

Of minor extent in this unit are Umpump and Rakied soils. These soils are moderately well drained and gravelly.

This unit is used for subsistence farming, woodland, watershed, and wildlife habitat.

If this unit is used for subsistence farming, woodland, or homesite development, the main limitations are wetness and a hazard of flooding.

2. Nanlak

Very deep, very poorly drained, level and nearly level soils; in coastal tidal marshes

This map unit is along the coast in most parts of the survey area. The unit is flooded daily with ocean saltwater during high tide. Slope is 0 to 2 percent. The vegetation on the unit is mainly mangrove forest. Elevation is sea level. The mean annual rainfall is about

400 to 500 centimeters, and the mean annual air temperature is about 27 degrees C.

This unit makes up about 14 percent of the survey area. It is about 80 percent Naniak soils. The remaining 20 percent is components of minor extent.

Naniak soils are in coastal tidal marshes. These soils are very deep and very poorly drained. They formed in alluvium derived dominantly from basic igneous rock. The soils are loamy and mucky to a depth of 60 centimeters and are loamy and gravelly between depths of 60 and 150 centimeters.

Of minor extent in this unit are Insak soils. These soils are shallow and sandy.

This unit is used for mangrove wood production and wildlife habitat.

soils on old lava flows, terraces, benches, and uplands

This group consists of three map units. It makes up about 82 percent of this survey area. The soils in this group are level to extremely steep. The native vegetation is mainly mixed forest. Elevation is 5 to 600 meters. The mean annual rainfall is about 450 to 650 centimeters, and the mean annual air temperature is about 25 to 27 degrees C.

The soils in this group are shallow, moderately deep, and very deep and are somewhat poorly drained to well drained. They formed in residuum and colluvium derived dominantly from basic igneous rock.

This group is used for subsistence farming, woodland, black pepper production, homesites, watershed, and wildlife habitat.

3. Umpump-Rakied

Moderately deep and very deep, moderately well drained and somewhat poorly drained, level to moderately steep soils; on old lava flows, terraces, and benches

This map unit is scattered throughout the survey area except on the steep mountains in the interior. Slope is 0 to 15 percent. The vegetation in areas not cultivated is mainly mixed forest. Elevation is 5 to 200 meters. The mean annual rainfall is about 450 to 550 centimeters, and the mean annual air temperature is about 27 degrees C.

This unit makes up about 13 percent of the survey area. It is about 65 percent Umpump soils and 20 percent Rakied soils. The remaining 15 percent is components of minor extent.

Umpump soils are on old, highly weathered lava flows. These soils are moderately deep and moderately well drained. They formed in residuum derived dominantly from basic igneous rock. The soils are loamy and gravelly throughout. Weathered basalt is at a depth of 50 to 100 centimeters.

Rakied soils are on old, highly weathered lava flows, terraces, and benches. These soils are very deep and somewhat poorly drained. They formed in residuum derived dominantly from basic igneous rock. The soils are loamy and are very gravelly and extremely gravelly throughout.

The soils in this unit have a water table between depths of 50 and 120 centimeters.

Of minor extent in this unit are small areas of somewhat poorly drained and poorly drained soils in depressional areas. Also included are well drained Dolekei, Dolen, and Tolonier soils that are more steeply sloping.

This unit is used for subsistence farming, woodland, black pepper production, and homesites.

This unit is moderately suited to subsistence farming and woodland. The main limitations are wetness and low soil fertility. If the unit is used as homesites, the main limitation is wetness.

4. Dolekei-Fomseng

Shallow and moderately deep, well drained, moderately steep to extremely steep soils; on uplands

This map unit is in the western and eastern parts of the survey area. Slope is 15 to 100 percent. The vegetation on the unit is mainly mixed forest. Elevation is 15 to 400 meters. The mean annual rainfall is about 450 to 600 centimeters, and the mean annual air temperature is about 25 to 27 degrees C.

This unit makes up about 24 percent of the survey area. It is about 50 percent Dolekei soils and 30 percent Fomseng soils. The remaining 20 percent is components of minor extent.

Dolekei soils are on uplands. These soils are moderately deep and well drained. They formed in residuum derived dominantly from basic igneous rock. The soils are loamy throughout. Weathered basalt is at a depth of 50 to 100 centimeters.

Fomseng soils are on uplands. These soils are shallow and well drained. They formed in residuum derived dominantly from basic igneous rock. The soils are loamy throughout. Weathered basalt is at a depth of 25 to 50 centimeters.

Of minor extent in this unit are Dolen, Tolonier, and Fomseng Variant soils. The Dolen and Tolonier soils are very deep, and the Fomseng Variant soils are very shallow.

This unit is used for subsistence farming, woodland, watershed, and wildlife habitat.

Most areas of this unit are moderately suited to subsistence farming and woodland. Some areas are poorly suited because of the shallow rooting depth and the hazard of erosion.

5. Tolonier-Dolen

Very deep, well drained, strongly sloping to extremely steep soils; on uplands

This map unit is mainly in the central part of the survey area. Slope is 6 to 100 percent. The vegetation on this unit is mainly mixed forest. Elevation is 6 to 600 meters. The mean annual rainfall is about 450 to 650 centimeters, and the mean annual air temperature is about 25 to 27 degrees C.

This unit makes up about 45 percent of the survey area. It is about 45 percent Tolonier soils and 30 percent Dolen soils. The remaining 25 percent is components of minor extent.

Tolonier soils are on uplands. These soils are very deep and well drained. They formed in residuum and colluvium derived dominantly from basic igneous rock. The soils are loamy and are very stony and extremely stony throughout.

Dolen soils are on uplands. These soils are very deep and well drained. They formed in residuum and colluvium derived dominantly from basic igneous rock. The soils are loamy throughout.

Of minor extent in this unit are the moderately deep Wahrekdam soils on ridgetops and small areas of Dolekei and Fomseng soils.

This unit is used for subsistence farming, woodland, watershed, and wildlife habitat.

Most areas of this unit are suited to subsistence farming and woodland. Some of the less sloping and less stony areas are well suited. Some areas are poorly suited because of slope, a hazard of erosion, and stoniness.

broad land use considerations

The soils of Ponape vary widely in their potential for major land uses. Approximately 30 percent of the land on Ponape is used for subsistence tree crops, mainly bananas, breadfruit, and coconuts. Subsistence tree crops are grown on all map units except unit 2. All of the soils in unit 1 are flooded occasionally and the Nansepsep and Inkosr soils in unit 1 have a high water table, which limits crop production. Map units 3, 4, and 5 are on uplands. The soils in these units generally are suited to subsistence tree crops, except in those areas that are too steep. Low soil fertility and wetness are also limitations of the soils in unit 3.

About 50 percent of the island is woodland. The productivity of adapted woodland species is high on the soils in unit 5 and is moderate on the soils of units 3 and 4. The use of equipment is restricted in some areas because of the steepness of slope and stoniness.

About 14 percent of the island is mangrove swamp, all of which is in unit 2. The mangrove swamps of Ponape are important as a source of mangrove wood and as wildlife habitat.

About 4 percent of Ponape is used for specialty crops such as vegetables and black pepper. These crops are grown mainly on units 3, 4, and 5. Drainage and fertilizer are needed on unit 3. Map units 4 and 5 are limited for such crops because of steepness of slope, a hazard of erosion, and in many areas, stoniness.

About 275 hectares, or 0.7 percent, of Ponape is classified as Urban land or is in Urban land-soil complexes. Most of these areas are in map unit 3. Wetness is the main limitation in these areas. Some urban development is suitable in the areas of map unit 5 that are not too steep or too stony.

The potential for recreational use ranges from low to high, depending on the intensity of the expected use and the properties of the soils. Map units 1 and 2 are limited by wetness and flooding. Unit 3 is limited by wetness. Units 4 and 5 are limited because of steepness of slope but are suited to recreational uses such as hiking, nature study, and wilderness.

The potential for wildlife habitat generally is high throughout the island. Map units 4 and 5 have high potential for woodland wildlife habitat, unit 1 has high potential for wetland wildlife habitat, and unit 2 has high potential for saline marsh wildlife habitat.

detailed soil map units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and management of the soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the map unit descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Umpump very gravelly clay loam, 2 to 8 percent slopes, is one of several phases in the Umpump series.

Some map units are made up of two or more major soils. These map units are called soil complexes.

A *soil complex* consists of two or more soils in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Rakied-Urban land complex, 0 to 5 percent slopes, is an example.

A *soil association* is made up of soils that are geographically associated. The soils are shown as one unit because similar interpretations can be made for use and management. A soil association has a regular geographic pattern. The extent of each soil can differ from one mapped area to another. Dolekei-Fomseng association, 30 to 60 percent slopes, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps. Some of the soils named as included areas in the map units were not mapped separately in this survey. These soils were mapped separately in the surveys of other islands in the Trust Territory of the Pacific Islands.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Urban land is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Table 1 gives the hectarage and proportionate extent of each map unit. Other tables (see "Summary of tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

map unit descriptions

300—Dolekei-Fomseng association, 15 to 30 percent slopes. This map unit is on uplands. Areas are irregular in shape and are 2 to 25 hectares in size. The vegetation is mainly mixed forest. Elevation is 15 to 300 meters. The mean annual rainfall is about 450 to 550 centimeters, and the mean annual air temperature is about 26 to 27 degrees C.

This unit is about 50 percent Dolekei silty clay loam and 30 percent Fomseng clay loam. The Fomseng soil is mainly on narrow ridges, and the Dolekei soil is mainly on the sides of ridges and in depressional areas. Where the slopes are complex, the Fomseng soil commonly is in convex areas and the Dolekei soil is in concave areas.

Included in this unit are small areas of Dolen and Tolonier soils. Also included are small areas of Dolekei and Fomseng soils that have cobbles on the surface or have slopes of more than 30 percent. Included areas make up about 20 percent of the total hectarage. The percentage varies from one area to another.

The Dolekei soil is moderately deep and well drained. It formed in residuum and colluvium derived from basic igneous rock. Typically, the surface layer is dark brown silty clay loam 8 centimeters thick. The subsoil is dark yellowish brown silty clay loam 28 centimeters thick. The substratum is yellowish brown silty clay loam 38 centimeters thick. Highly weathered bedrock is at a depth of 74 centimeters. Depth to bedrock ranges from 50 to 100 centimeters.

Permeability of the Dolekei soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 50 to 100 centimeters. Runoff is medium, and the hazard of water erosion is moderate.

The Fomseng soil is shallow and well drained. It formed in residuum derived from basic igneous rock. Typically, the surface layer is dark brown clay loam 8 centimeters thick. The upper 7 centimeters of the subsoil is dark yellowish brown silty clay, and the lower 21 centimeters is dark yellowish brown cobbly clay loam. Highly weathered basalt is at a depth of 36 inches. Depth to basalt ranges from 25 to 50 centimeters.

Permeability of the Fomseng soil is moderately rapid. Available water capacity is low. Effective rooting depth is 25 to 50 centimeters. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for subsistence farming, woodland, homesites, watershed, and wildlife habitat.

This unit is suited to subsistence farming. It is limited mainly by low soil fertility and by the shallow rooting depth and low available water capacity of the Fomseng soil. Adapted crops such as bananas, breadfruit, and coconuts can be grown successfully on the Dolekei soil if the organic matter content is maintained. This can be done by leaving all plant residue on the surface and adding mulch and compost. Burning the vegetation on this unit destroys needed organic matter, and it reduces soil fertility.

The Dolekei soil is suited to the production of adapted woodland species such as *Campnosperma brevipetiolata*, *Elaeocarpus carolinensis*, and *Adenanthera pavonina*. The Fomseng soil is poorly suited to use as woodland because of the shallow rooting depth and low available water capacity.

The main concerns in producing and harvesting timber on the Dolekei soil are the hazard of erosion and plant competition. Minimizing the risk of erosion is essential in harvesting timber. After harvesting, reforestation must be carefully managed to reduce competition from undesirable understory plants. If the planting site is not adequately prepared, such competition can prevent or prolong natural or artificial reestablishment of trees. Hand planting of nursery stock is usually necessary to establish or improve a stand.

This unit is poorly suited to homesite development. The Dolekei soil is limited by slope and low soil strength, and the Fomseng soil is limited by slope and shallow soil depth. The steepness of slope is a concern in installing septic tank absorption fields. Absorption lines should be installed in areas of the deeper Dolekei soil and should be placed on the contour.

If roads are constructed on this unit, the limitation of low soil strength can be overcome by using an adequate amount of crushed coral or basalt ballast. Allow the soil material to dry sufficiently before filling and compacting areas of the unit. Cutbanks are not stable and are subject to slumping.

301—Dolekei-Fomseng association, 30 to 60 percent slopes. This map unit is on uplands. Areas are irregular in shape and are 2 to 25 hectares in size. The vegetation is mainly mixed forest. Elevation is 15 to 400 meters. The mean annual rainfall is about 450 to 600 centimeters, and the mean annual air temperature is about 25 to 27 degrees C.

This unit is about 50 percent Dolekei silty clay loam and 30 percent Fomseng clay loam. The Fomseng soil is mainly on narrow ridges, and the Dolekei soil is mainly on the sides of ridges. Where the slopes are complex, the Fomseng soil generally is in convex areas and the Dolekei soil is in concave areas.

Included in this unit are small areas of Dolen and Tolonier soils. Also included are small areas of Dolekei and Fomseng soils that have cobbles on the surface or have slopes of more than 60 percent. Included areas make up about 20 percent of the total hectarage. The percentage varies from one area to another.

The Dolekei soil is moderately deep and well drained. It formed in residuum and colluvium derived from basic igneous rock. Typically, the surface layer is dark brown silty clay loam 8 centimeters thick. The subsoil is dark yellowish brown silty clay loam 28 centimeters thick. The substratum is yellowish brown silty clay loam 38 centimeters thick. Highly weathered bedrock is at a depth of 74 centimeters. Depth to bedrock ranges from 50 to 100 centimeters.

Permeability of the Dolekei soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 50 to 100 centimeters. Runoff is rapid, and the hazard of water erosion is high.

The Fomseng soil is shallow and well drained. It formed in residuum derived from basic igneous rock. Typically, the surface layer is dark brown clay loam 8 centimeters thick. The upper 7 centimeters of the subsoil is dark yellowish brown silty clay, and the lower 21 centimeters is dark yellowish brown cobbly clay loam. Highly weathered basalt is at a depth of 36 centimeters. Depth to basalt ranges from 25 to 50 centimeters.

Permeability of the Fomseng soil is moderately rapid. Available water capacity is low. Effective rooting depth is 25 to 50 centimeters. Runoff is rapid, and the hazard of water erosion is high.

This unit is used for subsistence farming, woodland, watershed, and wildlife habitat.

The Dolekei soil is suited to the production of adapted crops such as bananas, breadfruit, and coconuts. The Fomseng soil is poorly suited because of the shallow rooting depth and low available water capacity. For sustained crop yields, the organic matter content of these soils should be maintained. This can be done by leaving all plant residue on the surface and adding mulch and compost. Burning the vegetation on these soils destroys needed organic matter, and it reduces soil fertility.

The Dolekei soil is suited to the production of adapted woodland species such as *Campnosperma brevipetiolata*, *Elaeocarpus carolinensis*, and *Adenanthera pavonina*. The Fomseng soil is poorly suited to use as woodland because of the shallow rooting depth, low available water capacity, and high hazard of erosion.

The main concerns in producing and harvesting timber on the Dolekei soil are the hazard of erosion, equipment limitations because of slope, and plant competition. Minimizing the risk of erosion is essential in harvesting timber. After harvesting, reforestation must be carefully managed to reduce competition from undesirable understory plants. If the planting site is not adequately prepared, such competition can prevent or prolong natural or artificial reestablishment of trees. Hand planting of nursery stock usually is necessary to establish or improve a stand.

If roads are constructed on this unit, the limitation of low soil strength can be overcome by using an adequate amount of crushed coral or basalt ballast. Allow the soil material to dry sufficiently after rainstorms before filling and compacting areas of this unit. Cutbanks are not stable and are subject to slumping.

302—Dolekei-Fomseng association, 15 to 30 percent slopes, cobbly. This map unit is on uplands. Areas are irregular in shape and are 2 to 25 hectares in size. The vegetation is mainly mixed forest. Elevation is 15 to 300 meters. The mean annual rainfall is about 450 to 550 centimeters, and the mean annual air temperature is about 26 to 27 degrees C.

This unit is about 50 percent Dolekei cobbly silty clay loam and 30 percent Fomseng cobbly clay loam. The Fomseng soil is mainly on narrow ridges, and the Dolekei soil is mainly on the sides of ridges and in depressional areas. Where the slopes are complex, the Fomseng soil commonly is in convex areas and the Dolekei soil is in concave areas.

Included in this unit are small areas of Dolen and Tolonier soils. Also included are small areas of Dolekei and Fomseng soils that do not have cobbles on the surface or that have slopes of more than 30 percent. Included areas make up about 20 percent of the total hectarage. The percentage varies from one area to another.

The Dolekei soil is moderately deep and well drained. It formed in residuum and colluvium derived from basic igneous rock. Typically, the surface layer is dark brown cobbly silty clay loam 8 centimeters thick. The subsoil is dark yellowish brown silty clay loam 28 centimeters thick. The substratum is yellowish brown silty clay loam 38 centimeters thick. Highly weathered bedrock is at a depth of 74 centimeters. Depth to bedrock ranges from 50 to 100 centimeters.

Permeability of the Dolekei soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 50 to 100 centimeters. Runoff is medium, and the hazard of water erosion is moderate.

The Fomseng soil is shallow and well drained. It formed in residuum derived from basic igneous rock. Typically, the surface layer is dark brown cobbly clay loam 8 centimeters thick. The upper 7 centimeters of the subsoil is dark yellowish brown silty clay, and the lower 21 centimeters is dark yellowish brown cobbly clay loam. Highly weathered basalt is at a depth of 36 centimeters. Depth to basalt ranges from 25 to 50 centimeters.

Permeability of the Fomseng soil is moderately rapid. Available water capacity is low. Effective rooting depth is 25 to 50 centimeters. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for subsistence farming, woodland, homesites, watershed, and wildlife habitat.

The Dolekei soil is suited to the production of adapted crops such as bananas, breadfruit, and coconuts. The main limitation is low soil fertility. For sustained crop yields, the organic matter content of the surface layer should be maintained. This can be done by leaving all plant residue on the surface and adding mulch and compost. Burning the vegetation on this soil destroys needed organic matter, and it reduces soil fertility. Crop yields can be increased by fertilizing with coral sand and potassium. Wood ash is a fair source of potassium.

The Fomseng soil is poorly suited to subsistence tree crop farming. It is limited mainly by shallow rooting depth and low available water capacity.

This unit is poorly suited to the production of row crops. It is limited mainly by low soil fertility, which results from the depletion of organic matter after the land is cleared, and by the hazard of erosion and cobbles on the surface. The Fomseng soil is also limited by shallow rooting depth and low available water capacity.

The Dolekei soil is suited to the production of adapted woodland species such as *Campnosperma brevipetiolata*, *Elaeocarpus carolinensis*, and *Adenanthera pavonina*. The Fomseng soil is poorly suited to use as woodland because of the shallow rooting depth and low available water capacity.

The main concerns in producing and harvesting timber on the Dolekei soil are the hazard of erosion, equipment limitations because of slope, and plant competition. Minimizing the risk of erosion is essential in harvesting timber. After harvesting, reforestation must be carefully managed to reduce competition from undesirable understory plants. If the planting site is not adequately prepared, such competition can prevent or prolong natural or artificial reestablishment of trees. Hand planting of nursery stock usually is necessary to establish or improve a stand.

The Dolekei soil is suited to homesite development. The main limitations are slope, cobbles on the surface, and low soil strength. The Fomseng soil is poorly suited to homesite development. The main limitations are slope, cobbles on the surface, shallow soil depth, and low soil strength. The steepness of slope is a concern in installing septic tank absorption fields. Absorption lines should be installed on the contour and in areas of the deeper Dolekei soil.

If roads are constructed on this unit, the limitation of low soil strength can be overcome by using an adequate amount of crushed coral or basalt ballast. Allow the soil material to dry sufficiently before filling and compacting areas of this unit. Cutbanks are not stable and are subject to slumping.

303—Dolekei-Fomseng association, 30 to 60 percent slopes, cobbly. This map unit is on uplands. Areas are irregular in shape and are 2 to 25 hectares in size. The vegetation is mainly mixed forest. Elevation is 15 to 400 meters. The mean annual rainfall is about 450 to 600 centimeters, and the mean annual air temperature is about 25 to 27 degrees C.

This unit is about 50 percent Dolekei cobbly silty clay loam and 30 percent Fomseng cobbly clay loam. The Fomseng soil is mainly on narrow ridges, and the Dolekei soil is mainly on the sides of ridges. Where the slopes are complex, the Fomseng soil commonly is in convex areas and the Dolekei soil is in concave areas.

Included in this unit are small areas of Dolen and Tolonier soils. Also included are small areas of Dolekei and Fomseng soils that do not have cobbles on the surface or that have slopes of more than 60 percent. Included areas make up about 20 percent of the total hectarage. The percentage varies from one area to another.

The Dolekei soil is moderately deep and well drained. It formed in residuum and colluvium derived from basic igneous rock. Typically, the surface layer is dark brown cobbly silty clay loam 8 centimeters thick. The subsoil is dark yellowish brown silty clay loam 28 centimeters thick. The substratum is yellowish brown silty clay loam 38 centimeters thick. Highly weathered bedrock is at a depth of 74 centimeters. Depth to bedrock ranges from 50 to 100 centimeters.

Permeability of the Dolekei soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 50 to 100 centimeters. Runoff is rapid, and the hazard of water erosion is high.

The Fomseng soil is shallow and well drained. It formed in residuum derived from basic igneous rock. Typically, the surface layer is dark brown cobbly clay loam 8 centimeters thick. The upper 7 centimeters of the subsoil is dark yellowish brown silty clay, and the lower 21 centimeters is dark yellowish brown cobbly clay loam. Highly weathered bedrock is at a depth of 36 centimeters. Depth to bedrock ranges from 25 to 50 centimeters.

Permeability of the Fomseng soil is moderately rapid. Available water capacity is low. Effective rooting depth is 25 to 50 centimeters. Runoff is rapid, and the hazard of water erosion is high.

This unit is used for subsistence farming, woodland, watershed, and wildlife habitat.

The Dolekei soil is suited to the production of adapted crops such as bananas, breadfruit, and coconuts. The Fomseng soil is poorly suited because of the shallow rooting depth and low available water capacity. For sustained crop yields, the organic matter content of these soils should be maintained. This can be done by leaving all plant residue on the surface and adding mulch and compost. Burning the vegetation on these soils destroys needed organic matter, and it reduces soil fertility.

This unit is poorly suited to the production of row crops. It is limited mainly by low soil fertility, which results from the depletion of organic matter after the land is cleared, and by the high hazard of erosion and cobbles on the surface. The Fomseng soil is also limited by shallow rooting depth and low available water capacity.

The Dolekei soil is suited to the production of adapted woodland species such as *Campnosperma brevipetiolata*, *Elaeocarpus carolinensis*, and *Adenanthera pavonina*. The Fomseng soil is poorly suited to use as woodland because of the shallow rooting depth, low available water capacity, and high hazard of erosion.

The main concerns in producing and harvesting timber on the Dolekei soil are the hazard of erosion, equipment limitations because of slope and cobbles on the surface, and plant competition. Minimizing the risk of erosion is essential in harvesting timber. After harvesting, reforestation must be carefully managed to reduce competition from undesirable understory plants. If the planting site is not adequately prepared, such competition can prevent or prolong natural or artificial reestablishment of trees. Hand planting of nursery stock usually is necessary to establish or improve a stand.

If roads are constructed on this unit, the limitation of low soil strength can be overcome by using an adequate amount of crushed coral or basalt ballast. Allow the soil material to dry sufficiently before filling and compacting areas of this unit. Cutbanks are not stable and are subject to slumping.

304—Dolen cobbly silty clay loam, 6 to 15 percent slopes. This very deep, well drained soil is on toe slopes of steep mountains. It formed in residuum and colluvium derived from basic igneous rock. Slopes generally are concave. Areas are irregular in shape and are 1 to 20 hectares in size. The vegetation is mainly mixed forest. Elevation is 6 to 200 meters. The mean annual rainfall is about 450 to 550 centimeters, and the mean annual air temperature is about 26 to 27 degrees C.

Typically, the surface layer is dark brown cobbly silty clay loam 5 centimeters thick. The upper 38 centimeters of the subsoil is dark yellowish brown silty clay loam, and the lower 74 centimeters is yellowish brown silty clay loam. The substratum to a depth of 150 centimeters or more is yellowish brown stony silty clay loam.

Included in this unit are small areas of Tolonier and Dolekei soils. Also included are small areas of Dolen soils that have slopes of more than 15 percent. Included areas make up about 20 percent of the total hectarage. The percentage varies from one area to another.

Permeability of this Dolen soil is moderately rapid. Available water capacity is high. Effective rooting depth is 150 centimeters or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly for subsistence farming. The main crops are bananas, breadfruit, and coconuts. Other crops such as tapioca, sugarcane, kava, and yams can be grown if the organic matter content of the soil is maintained. The unit is also used as woodland and homesites.

This unit is well suited to subsistence farming. If the unit is used for crops, a continuing supply of organic material to the soil is essential for sustained yields. Organic material can be supplied by the use of crop residue, mulch, or compost. Yields can be increased by fertilizing with potassium and coral sand. Wood ash is a fair source of potassium. Burning the vegetation on this unit destroys organic matter, and it reduces soil fertility.

This unit is well suited to adapted woodland species such as *Adenanthera pavonina*, *Campnosperma brevipetiolata*, *Elaeocarpus carolinensis*, and *Parinarium glaberrium*. Introduced trees that are suitable for planting are *Eucalyptus saligna, Eucalyptus deglupta*, *Swietenia macrophylla*, and *Tectona grandis*.

The main concern in producing timber on this unit is plant competition. Reforestation must be carefully managed to reduce competition from undesirable understory plants. If the site is not adequately prepared, such competition can prevent or prolong natural or artificial reestablishment of trees. Competing vegetation can be controlled by properly preparing the site and by spraying, cutting, or girdling to eliminate unwanted weeds, brush, or trees. Hand planting of nursery stock usually is necessary to establish or improve a stand.

This unit is well suited to homesite development. The main limitation is large stones on the surface.

305—Dolen cobbly silty clay loam, 15 to 30 percent slopes. This deep, well drained soil is on foot slopes of mountains. It formed in residuum and colluvium derived from basic igneous rock. Slopes generally are concave. Areas are irregular in shape and are 2 to 20 hectares in size. The vegetation is mainly mixed forest. Elevation is 6 to 200 meters. The mean annual rainfall is about 450 to 550 centimeters, and the mean annual air temperature is about 26 to 27 degrees C.

Typically, the surface layer is dark brown cobbly silty clay loam 5 centimeters thick. The upper 38 centimeters of the subsoil is dark yellowish brown silty clay loam, and the lower 74 centimeters is yellowish brown silty clay loam. The substratum to a depth of 150 centimeters or more is yellowish brown stony silty clay loam.

Included in this unit are small areas of Tolonier and Dolekei soils. Also included are small areas of Dolen soils that have slopes of less than 15 percent. Included areas make up about 20 percent of the total hectarage. The percentage varies from one area to another.

Permeability of the Dolen soil is moderately rapid. Available water capacity is high. Effective rooting depth is 150 centimeters or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used mainly for subsistence farming and as woodland and homesites. It is also used as watershed and for wildlife habitat.

This unit is well suited to the production of adapted subsistence crops such as bananas, breadfruit, and coconuts. Crops such as tapioca, sugarcane, kava, and yams can also be grown if the organic matter content of the soil is maintained. A continuing supply of organic matter to the soil is essential for sustained crop yields. This can be accomplished by the use of crop residue, mulch, or compost. Yields can be increased by fertilizing with potassium and coral sand. Wood ash is a fair source of potassium. Burning the vegetation on this unit destroys organic matter, and it reduces soil fertility.

This unit is suited to adapted woodland species such as *Adenanthera pavonina*, *Campnosperma brevipetiolata*, *Elaeocarpus carolinensis*, and *Parinarium glaberrium*. Introduced trees that are suitable for planting are *Eucalyptus saligna*, *Eucalyptus deglupta*, *Swietenia macrophylla*, and *Tectona grandis*.

The main concerns in producing and harvesting timber are the hazard of erosion, equipment limitations because of slope and cobbles on the surface, and plant competition. Minimizing the risk of erosion is essential in harvesting timber. After harvesting, reforestation must be carefully managed to reduce competition from undesirable understory plants. If the planting site is not adequately prepared, such competition can prevent or prolong natural or artificial reestablishment of trees. Competing vegetation can be controlled by properly preparing the site and by spraying, cutting, or girdling to eliminate unwanted weeds, brush, or trees. Hand planting of nursery stock usually is necessary to establish or improve a stand.

This unit is suited to homesite development. The main limitations are the hazard of erosion, slope, and cobbles on the surface. Preserving the existing plant cover during construction helps to control erosion. Slope is a concern in installing septic tank absorption fields. Absorption lines should be installed on the contour.

If roads are constructed on this unit, the limitation of low soil strength can be overcome by using an adequate amount of crushed coral or basalt ballast. Allow the soil material to dry sufficiently before filling and compacting areas of this unit. Access roads should be designed to control surface runoff and help stabilize cut slopes. Cutbanks are subject to slumping.

306—Fomseng-Dolekei association, 60 to 100 percent slopes. This map unit is on uplands. Slopes generally are complex. Areas are irregular in shape and are 2 to 25 hectares in size. The vegetation is mainly mixed forest. Elevation is 50 to 400 meters. The mean annual rainfall is about 450 to 600 centimeters, and the mean annual air temperature is about 25 to 27 degrees C.

This unit is about 50 percent Fomseng clay loam and 30 percent Dolekei silty clay loam. The Fomseng soil commonly is in convex areas, and the Dolekei soil is in concave areas.

Included in this unit are small areas of Dolen and Tolonier soils and rock outcroppings. Also included are small areas of Dolekei and Fomseng soils that have cobbles on the surface or have slopes of more than 100 percent. Included areas make up about 20 percent of the total hectarage. The percentage varies from one area to another.

The Fomseng soil is shallow and well drained. It formed in residuum derived from basic igneous rock. Typically, the surface layer is dark brown clay loam 8 centimeters thick. The upper 7 centimeters of the subsoil is dark yellowish brown silty clay, and the lower 21 centimeters is dark yellowish brown cobbly clay loam. Highly weathered bedrock is at a depth of 36 centimeters. Depth to bedrock ranges from 25 to 50 centimeters.

Permeability of the Fomseng soil is moderately rapid. Available water capacity is low. Effective rooting depth is 25 to 50 centimeters. Runoff is rapid, and the hazard of water erosion is very high.

The Dolekei soil is moderately deep and well drained. It formed in residuum and colluvium derived from basic igneous rock. Typically, the surface layer is dark brown silty clay loam 8 centimeters thick. The subsoil is dark yellowish brown silty clay loam 28 centimeters thick. The substratum is yellowish brown silty clay loam 38 centimeters thick. Highly weathered bedrock is at a depth of 74 centimeters. Depth to bedrock ranges from 50 to 100 centimeters.

Permeability of the Dolekei soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 50 to 100 centimeters. Runoff is rapid, and the hazard of water erosion is very high.

This unit is used as watershed and for wildlife habitat.

This unit is poorly suited to use as woodland and for crop production because of steepness of slope and the very high hazard of erosion.

307—Fomseng Variant silt loam, 15 to 30 percent slopes. This very shallow, well drained soil is on uplands. It formed in residuum derived from basic igneous rock. Slopes are convex. Areas are irregular in shape and are 1 to 10 hectares in size. The vegetation is mainly low-growing ferns and grasses. Elevation is 20 to 250 meters. The mean annual rainfall is about 450 to 600 centimeters, and the mean annual air temperature is about 25 to 27 degrees C.

Typically, the surface layer is dark yellowish brown silt loam 10 centimeters thick. The subsoil is strong brown silty clay loam 7 centimeters thick. Highly weathered bedrock is at a depth of 17 centimeters. Depth to bedrock ranges from 10 to 25 centimeters.

Included in this unit are small areas of Fomseng soils and rock outcroppings. Also included are small areas of Fomseng Variant soils that have stones on the surface or have slopes of more than 30 percent. Included areas make up about 20 percent of the total hectarage. The percentage varies from one area to another.

Permeability of the Fomseng Variant soil is moderate. Available water capacity is very low. Effective rooting depth is 10 to 25 centimeters. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for wildlife habitat.

This unit is poorly suited to crop production. It is limited mainly by shallow rooting depth, low available water capacity, low soil fertility, and slope.

308—Fomseng Variant silt loam, 30 to 60 percent slopes. This very shallow, well drained soil is on uplands. It formed in residuum derived from basic igneous rock. Slopes are convex. Areas are irregular in shape and are 1 to 10 hectares in size. The vegetation is mainly low-growing ferns and grasses. Elevation is 20 to 250 meters. The mean annual rainfall is about 450 to 600 centimeters, and the mean annual air temperature is about 25 to 27 degrees C.

Typically, the surface layer is dark yellowish brown silt loam 10 centimeters thick. The subsoil is strong brown silty clay loam 7 centimeters thick. Highly weathered bedrock is at a depth of 17 centimeters. Depth to bedrock ranges from 10 to 25 centimeters.

Included in this unit are small areas of Fomseng soils and rock outcroppings. Also included are small areas of Fomseng Variant soils that have stones on the surface or have slopes of less than 30 percent. Included areas make up about 20 percent of the total hectarage. The percentage varies from one area to another.

Permeability of the Fomseng Variant soil is moderate. Available water capacity is very low. Effective rooting depth is 10 to 25 centimeters. Runoff is rapid, and the hazard of water erosion is high.

This unit is used for wildlife habitat.

This unit is poorly suited to crop production. It is limited mainly by shallow rooting depth, low available water capacity, low soil fertility, and slope.

309—Inkosr gravelly sandy clay loam, 0 to 2 percent slopes. This very deep, poorly drained soil is on bottom lands. It formed in alluvium derived dominantly from basic igneous rock. Areas are irregular in shape and are 2 to 20 hectares in size. The vegetation in areas not cultivated is mainly swamp forest or water tolerant grasses and sedges. Elevation is 1 to 15 meters. The mean annual rainfall is about 400 to 500 centimeters, and the mean annual air temperature is about 27 degrees C.

Typically, the surface layer is very dark grayish brown gravelly sandy clay loam 10 centimeters thick. The upper 25 centimeters of the subsoil is olive gray gravelly sandy clay loam that has light olive brown mottles, and the lower 75 centimeters is gray clay. The substratum to a depth of 150 centimeters or more is dark greenish gray silty clay loam. In some areas the surface layer is silty clay loam or gravelly silty clay loam.

Included in this unit are small areas of Nansepsep soils. Also included are small areas of soils that are similar to this Inkosr soil but have a buried organic layer at a depth of about 100 centimeters. Included areas make up about 15 percent of the total hectarage. The percentage varies from one area to another.

Permeability of the Inkosr soil is moderate. Available water capacity is high. Effective rooting depth is about 150 centimeters or more for water tolerant plants. Runoff is slow, and the hazard of water erosion is slight. A high water table is at a depth of 15 to 60 centimeters throughout the year. This soil is subject to occasional, brief periods of flooding throughout the year.

This unit is used mainly for rice. A few areas are used for wetland taro. *Cyrtosperma chamissonis* and *Colocasia esculenta* are the main species of wetland taro grown.

This unit is well suited to rice, although fertilization and water management are necessary for sustained high yields. The unit is also well suited to wetland taro. For sustained yields, additions of organic matter, water management, weed control, and proper spacing of plants are needed.

This unit is poorly suited to homesite development. The main limitations are wetness and the hazard of flooding. If roads are constructed on this unit, the limitation of low soil strength can be overcome by using an adequate amount of crushed coral or basalt ballast. Allow the soil material to dry sufficiently before filling and compacting areas of this unit. Roads should be located above the expected flood level.

310—Mesei Variant mucky peat, 0 to 2 percent slopes. This moderately deep, very poorly drained soil is in closed depressional areas and basins on bottom lands and on uplands. It formed in decaying plant material. Areas are irregular in shape and are 1 to 10 hectares in size. The native vegetation is mainly water tolerant grasses and sedges. Elevation is 10 to 100 meters. The mean annual rainfall is about 450 to 500 centimeters, and the mean annual air temperature is about 27 degrees C.

Typically, the surface layer is black mucky peat 42 centimeters thick. The subsoil is dark reddish brown mucky peat 20 centimeters thick. Hard basalt is at a depth of 62 centimeters. Depth to basalt ranges from 50 to 75 centimeters.

Included in this unit are small areas of Inkosr soils. Also included are small areas of organic soils that are similar to this Mesei Variant soil but are less than 50 centimeters deep over hard basalt. Included areas make up about 25 percent of the total hectarage. The percentage varies from one area to another.

Permeability of this Mesei Variant soil is rapid. Available water capacity is moderate. Effective rooting depth is 50 to 75 centimeters. Runoff is very slow or ponded, and the hazard of water erosion is slight. A high water table fluctuates between the surface and a depth of 15 centimeters throughout the year.

This unit is used for the production of wetland taro. *Cyrtosperma chamissionis* and *Colocasia esculenta* are the main species grown.

This unit is suited to the production of wetland taro. It is limited mainly by the restricted rooting depth. For sustained yields, additions of organic matter, weed control, and proper spacing are needed.

311—Naniak mucky silt loam, 0 to 2 percent slopes. This very deep, very poorly drained soil is in coastal tidal marshes. It formed in alluvium derived from basic igneous rock. Areas are irregular in shape and are 1 to 100 hectares in size. The native vegetation is mainly mangrove forest. Elevation is sea level. The mean annual rainfall is about 450 centimeters, and the mean annual air temperature is about 27 degrees C.

Typically, the surface layer is black mucky silt loam 30 centimeters thick. The next layer to a depth of 46 centimeters is black mucky loam. Below this to a depth of 152 centimeters or more is black and very dark gray mucky loam, gravelly loam, and very gravelly loam. Depth to bedrock ranges from 100 to 150 centimeters or more.

Included in this unit are small areas of Insak soils. Also included are small areas of soils that are similar to this Naniak soil but are less than 100 centimeters deep over bedrock. Included areas make up about 20 percent of the total hectarage. The percentage varies from one area to another.

Permeability of this Naniak soil is moderate. Available water capacity is high. Effective rooting depth is 100 centimeters or more. Runoff is slow, and the hazard of water erosion is slight. A high water table fluctuates from 30 centimeters above the surface to 30 centimeters below the surface throughout the year. This soil is flooded daily with ocean saltwater during periods of high tide. It has a high content of sulfidic material, which makes it extremely acidic if drained.

This unit is used for mangrove wood production and wildlife habitat.

This unit is well suited to *Bruguiera gymnorhiza*, *Rhizophora apiculata*, *Rhizophora mucronata*, *Sonneratia alba*, and *Xylocarpus granatum*. The *Sonneratia alba* and *Bruguiera gymnorhiza* are used for lumber and posts, the *Rhizophora apiculata* is used for firewood and posts, and the *Xylocarpus granatum* is used for woodcarving and other handicrafts. *Nipa fruticans* also grows well on this unit. It is used as thatch roof material. The main concerns in harvesting trees from the mangrove forests are equipment limitations because of wetness and daily flooding at high tide. Clearcutting is not advisable, because it delays natural regeneration and destroys wildlife habitat.

312—Nansepsep silt loam, 0 to 2 percent slopes. This very deep, somewhat poorly drained soil is on bottom lands. It formed in alluvium derived from basic igneous rock. Areas are irregular in shape and are 2 to 25 hectares in size. The vegetation is mainly mixed forest. Elevation is 2 to 100 meters. The mean annual rainfall is about 400 to 500 centimeters, and the mean annual air temperature is about 27 degrees C.

Typically, the surface layer is dark brown silt loam 10 centimeters thick. The upper 12 centimeters of the subsoil is dark brown silt loam, and the lower 78 centimeters is dark grayish brown silty clay loam and has strong brown mottles. The substratum to a depth of 150 centimeters or more is dark greenish gray silty clay loam. In some areas the surface layer is silty clay loam.

Included in this unit are small areas of Inkosr and Sonahnpil soils. Included areas make up about 15 percent of the total hectarage. The percentage varies from one area to another.

Permeability of the Nansepsep soil is moderate. Available water capacity is high. Effective rooting depth is 150 centimeters or more for water tolerant plants but is limited to depths between 50 and 75 centimeters for plants that are not water tolerant. Runoff is slow, and the hazard of water erosion is slight. A high water table is at a depth of 50 to 75 centimeters throughout the year. This soil is subject to occasional, very brief periods of flooding.

This unit is used mainly for subsistence farming. The main crops are bananas and coconuts. The unit is also used as watershed and for wildlife habitat.

This unit is suited to subsistence farming. It is limited mainly by wetness and the hazard of flooding. The organic matter content of the soil in this unit should be improved and maintained for sustained yields. This can be done by the use of crop residue, mulch, cover crops, and compost. Burning the vegetation on this unit destroys needed organic matter, and it reduces fertility. Most climatically adapted crops can be grown if the unit is protected from flooding, artificial drainage is provided, and commercial fertilizer is used.

This unit is poorly suited to homesite development. The main limitations are low soil strength, wetness, and the hazard of flooding. If roads are constructed on this unit, the limitation of low soil strength can be overcome by using an adequate amount of crushed coral or basalt ballast.

313—Ngedebus-Rubble land association, 0 to 2 percent slopes. This map unit is on coral reef islands and islets. Areas generally are long and narrow and are 1 to 5 hectares in size. The native vegetation is mainly atoll strand forest. Elevation is sea level to 5 meters. The mean annual rainfall is about 400 to 450 centimeters, and the mean annual air temperature is about 27 degrees C.

This unit is about 50 percent Ngedebus fine sand and 30 percent Rubble land. The Ngedebus soil generally is in the center of coral islets, but it commonly extends to the side of the islets, near the lagoon. Rubble land generally is on the side of the islets, near the ocean, but it extends to the center of the islets in some areas.

Included in this unit are small areas of poorly drained sandy soils. Also included are small areas of beach sand and gravel. Included areas make up about 20 percent of the total hectarage. The percentage varies from one area to another.

The Ngedebus soil is very deep and somewhat excessively drained. It formed in water- and wind-deposited sand derived dominantly from coral. Typically, the surface layer is very dark gray fine sand 13 centimeters thick. The next layer is light brownish gray fine sand 57 centimeters thick. Below this to a depth of 150 centimeters or more is very pale brown sand.

Permeability of the Ngedebus soil is rapid. Available water capacity is low. Effective rooting depth is 150 centimeters or more. Runoff is very slow, and the hazard of water erosion is slight. A water table is at a depth of 100 centimeters or more throughout the year. This soil is subject to occasional, very brief periods of flooding during high-intensity storms.

Rubble land is deep and excessively drained. It consists of water-deposited coral gravel, cobbles, and stones. Sand is in some of the voids between the coarse fragments. In many areas the surface is covered with a thin layer of organic debris.

Permeability of Rubble land is very rapid. Available water capacity is very low. Effective rooting depth is 100 to 150 centimeters or more. Rubble land is subject to brief periods of flooding caused by ocean waves during high-intensity storms. Although erosion generally is very severe during these storms, sand and coral fragments may be deposited in some areas.

This unit is used for coconut production.

This unit is well suited to coconut production. For sustained yields, the organic matter content of the soil must be maintained. This can be done by the use of cover crops, mulch, crop residue, and compost. Burning the vegetation on this unit destroys needed organic matter, and it reduces soil fertility.

314—Rakied extremely gravelly sandy loam, 0 to 5 percent slopes. This very deep, somewhat poorly drained soil is on uplands and terraces. It formed in residuum derived from basic igneous rock. Areas are irregular in shape and are 2 to 20 hectares in size. The vegetation is mainly mixed forest. Elevation is 10 to 200 meters. The mean annual rainfall is about 450 to 500 centimeters, and the mean annual air temperature is about 27 degrees C.

Typically, the upper part of the surface layer is very dark brown extremely gravelly sandy loam 13 centimeters thick. The lower part is very dark brown extremely gravelly sandy clay loam 28 centimeters thick. The upper 10 centimeters of the subsoil is variegated brown and red very gravelly sandy clay loam, the next 40 centimeters is dark brown very gravelly clay loam, and the lower 31 centimeters is strong brown very gravelly sandy clay loam. The substratum to a depth of 152 centimeters or more is strong brown very gravelly sandy clay loam.

Included in this unit are small areas of Umpump soils and some poorly drained soils that are mainly in depressional areas. Also included are small areas of soils that are similar to this Rakied soil but have stones or cobbles on the surface. Included areas make up about 20 percent of the total hectarage. The percentage varies from one area to another.

Permeability of the Rakied soil is moderately rapid to a depth of about 100 centimeters and moderately slow below this depth. Available water capacity is low to a depth of 40 centimeters and moderate below this depth. Effective rooting depth is about 100 centimeters. Runoff is slow, and the hazard of water erosion is slight. A high water table is at a depth of 80 to 120 centimeters throughout the year.

This unit is used for subsistence farming and homesite development. It can be used for commercial production of black pepper if fertilizer is used and drainage is installed.

This unit is suited to subsistence farming. It is limited mainly by wetness, low soil fertility, and the low available water capacity of the surface layer. Most climatically adapted crops can be grown if artificial drainage is provided. For sustained yields of crops, the organic matter content of the surface layer should be increased and maintained. This can be accomplished by the use of plant residue, mulch, and compost. Commercial fertilizer and lime can also be used to improve the fertility of the soil. Burning vegetation on this unit destroys needed organic matter, and it reduces soil fertility.

Vegetable gardens are difficult to establish on this unit because of the low available water capacity of the surface layer. This limitation can be overcome by mixing the surface layer with compost before planting and mulching.

This unit is suited to homesite development. The main limitation is wetness. This limitation can be greatly reduced by installing drainage ditches. Septic tank absorption fields do not function properly; therefore, sewers and sewage treatment facilities should be used.

315—Rakied extremely gravelly sandy loam, 0 to 2 percent slopes, high water table. This very deep, somewhat poorly drained soil is on low terraces. It formed in residuum derived from basic igneous rock. Areas are irregular in shape and are 2 to 20 hectares in size. The vegetation is mainly mixed forest. Elevation is 10 to 20 meters. The mean annual rainfall is about 450 centimeters, and the mean annual air temperature is about 27 degrees C.

Typically, the upper part of the surface layer is very dark brown extremely gravelly sandy loam 13 centimeters thick. The lower part is very dark brown extremely gravelly sandy clay loam 28 centimeters thick. The upper 10 centimeters of the subsoil is variegated brown and red very gravelly sandy clay loam, the next 40 centimeters is dark brown very gravelly clay loam, and the lower 31 centimeters is strong brown very gravelly sandy clay loam. The substratum to a depth of 152 centimeters or more is strong brown very gravelly sandy clay loam.

Included in this unit are small areas of Umpump, Inkosr, and Nansepsep soils. Included areas make up about 15 percent of the total hectarage. The percentage varies from one area to another.

Permeability of the Rakied soil is moderately rapid to a depth of about 100 centimeters and moderately slow below this depth. Available water capacity is low to a depth of 40 centimeters and moderate below this depth. Effective rooting depth is about 150 centimeters or more. Runoff is slow, and the hazard of water erosion is slight. A high water table is at a depth of 50 to 80 centimeters throughout the year.

This unit is used for subsistence farming and homesite development.

This unit is poorly suited to subsistence farming. It is limited mainly by wetness, low soil fertility, and the low available water capacity of the surface layer. These limitations can be overcome by installing drainage ditches, using fertilizer and lime, and mixing large amounts of organic matter such as compost into the surface layer. Burning the vegetation on this unit destroys needed organic matter, and it reduces soil fertility.

This unit is suited to homesite development. The main limitation is wetness. This limitation can be greatly reduced by installing drainage ditches. Septic tank absorption fields do not function properly; therefore, sewers and sewage treatment facilities should be used.

316—Rakied-Urban land complex, 0 to 5 percent slopes. This map unit is on old, highly weathered lava flows on uplands. Areas are irregular in shape and are 2 to 20 hectares in size. Elevation is 10 to 75 meters. The mean annual rainfall is about 450 centimeters, and the mean annual air temperature is about 27 degrees C.

This unit is 45 percent Rakied extremely gravelly sandy loam and 35 percent Urban land. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Umpump soils. Also included are small areas of soils that are similar to the Rakied soil but have stones on the surface. Included areas make up about 20 percent of the total hectarage. The percentage varies from one area to another.

The Rakied soil is very deep and somewhat poorly drained. It formed in residuum derived from basic igneous rock. Typically, the upper part of the surface layer is very dark brown extremely gravelly sandy loam 13 centimeters thick. The lower part is very dark brown extremely gravelly sandy clay loam 28 centimeters thick. The upper 10 centimeters of the subsoil is variegated dark brown and red very gravelly sandy clay loam, the next 40 centimeters is dark brown very gravelly clay loam, and the lower 31 centimeters is strong brown very gravelly sandy clay loam. The substratum to a depth of 152 centimeters or more is strong brown gravelly sandy clay loam.

Permeability of the Rakied soil is moderately rapid to a depth of 50 centimeters and moderately slow below this depth. Available water capacity is moderate. Effective rooting depth is 150 centimeters or more. Runoff is slow, and the hazard of water erosion is slight. A high water table is at a depth of 75 to 120 centimeters throughout the year.

The Urban land areas of this unit are mostly covered with buildings, roads, or crushed coral fill.

This unit is used for urban and homesite development. It is suited to this use. The main limitation is wetness. Septic tank absorption fields do not function properly; therefore, sewers and sewage treatment facilities should be used. Drainage ditches and storm drains are needed to remove excess surface runoff.

317—Sonahnpil very stony silty clay loam, 0 to 5 percent slopes. This very deep, well drained soil is on alluvial flood plains and alluvial fans. It formed in alluvium derived from basic igneous rock. Areas are long and narrow and are 1 to 5 hectares in size. The native vegetation is mainly trees, vines, and coarse grasses. Elevation is sea level to 100 meters. The mean annual rainfall is about 450 to 550 centimeters, and the mean annual air temperature is about 27 degrees C.

Typically, the surface is covered with a mat of leaves and twigs 2 centimeters thick. The surface layer is very dark brown very stony silty clay loam 18 centimeters thick. The upper 32 centimeters of the subsoil is dark brown cobbly silty clay loam and extremely stony sandy clay loam, and the lower 26 centimeters is dark yellowish brown very stony sandy clay loam. The substratum to a depth of 150 centimeters or more is dark yellowish brown very stony sandy clay loam.

Included in this unit are small areas of Nansepsep soils and poorly drained, stony alluvial soils. Also included are small areas of nonstony alluvial soils. Included areas make up about 20 percent of the total hectarage. The percentage varies from one area to another.

Permeability of this Sonahnpil soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 150 centimeters or more. Runoff is slow, and the hazard of water erosion is slight. This soil is subject to occasional periods of flooding during prolonged, high-intensity storms. Channeling and deposition are common along streambanks.

This unit is used for subsistence farming, as woodland and watershed, and for wildlife habitat.

This unit is suited to the production of adapted crops such as bananas, breadfruit, and coconuts. It is limited mainly by the hazard of flooding. A continuing supply of organic material to the soil from fallen leaves and branches or from compost is essential for sustained yields of crops.

This unit is poorly suited to the production of row crops. It is limited mainly by stoniness and the hazard of flooding.

This unit is suited to adapted woodland species such as *Barringtonia racemosa*, *Elaeocarpus carolinensis*, and *Campnosperma brevipetiolata*.

The main concerns in producing and harvesting timber are plant competition, equipment limitations because of stoniness, and seedling mortality because of the hazard of flooding. Stones on the surface can interfere with felling, yarding, and other operations involving the use of equipment. If the site is not adequately prepared, competition from undesirable plants can prevent or prolong natural or artificial reestablishment of trees.

Hand planting of nursery stock usually is necessary to establish or improve a stand.

This unit is poorly suited to homesite development. The main limitations are stoniness and the hazard of flooding.

If roads are constructed on this unit, the limitation of low soil strength can be overcome by using an adequate amount of crushed coral or basalt ballast. Allow the soil material to dry sufficiently before filling and compacting areas of this unit. Roads should be located above the expected flood level.

318—Tolonier-Dolen association, 30 to 60 percent slopes. This map unit is on uplands. Slopes generally are concave and complex. Areas are irregular in shape and are 5 to 50 hectares in size. The vegetation is mainly mixed forest. Elevation is 6 to 600 meters. The mean annual rainfall is about 450 to 650 centimeters, and the mean annual air temperature is about 25 to 27 degrees C.

This unit is about 50 percent Tolonier very stony clay loam and 30 percent Dolen cobbly silt loam.

Included in this unit are small areas of Dolekei and Fomseng soils. Also included are small areas of Tolonier and Dolen soils that have slopes of less than 30 percent and areas of soils that are similar to the Tolonier soil but have an extremely stony surface. Included areas make up about 20 percent of the total hectarage. The percentage varies from one area to another.

The Tolonier soil is very deep and well drained. It formed in residuum and colluvium derived from basic igneous rock. Typically, the upper 10 centimeters of the surface layer is dark brown very stony clay loam and the lower 15 centimeters is dark brown very stony silty clay loam. The upper 20 centimeters of the subsoil is dark yellowish brown stony clay loam, and the lower 50 centimeters is dark brown extremely stony silty clay. The substratum to a depth of 180 centimeters or more is brown and strong brown extremely stony clay loam.

Permeability of the Tolonier soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 150 centimeters or more. Runoff is rapid, and the hazard of water erosion is high.

The Dolen soil is very deep and well drained. It formed in residuum and colluvium derived from basic igneous rock. Typically, the surface layer is dark brown cobbly silt loam 5 centimeters thick. The upper 38 centimeters of the subsoil is dark yellowish brown silty clay loam, and the lower 74 centimeters is yellowish brown silty clay loam. The substratum to a depth of 200 centimeters or more is dark brown stony silty clay loam.

Permeability of the Dolen soil is moderately rapid. Available water capacity is high. Effective rooting depth is 150 centimeters or more. Runoff is rapid, and the hazard of water erosion is high.

This unit is used for subsistence farming, woodland, watershed, and wildlife habitat.

This unit is suited to adapted crops such as bananas, breadfruit, and coconuts. It is limited mainly by steepness of slope, the hazard of erosion, and the stoniness of the Tolonier soil. A continuing supply of organic matter from fallen leaves and branches or from compost is essential for sustained crop yields. Burning the vegetation on this unit destroys needed organic matter, and it reduces soil fertility.

This unit is suited to adapted tropical woodland species such as *Campnosperma brevipetiolata*, *Elaeocarpus carolinensis*, *Adenanthera pavonina*, and *Parinarium glaberrium*. Introduced species suitable for planting are *Eucalyptus saligna*, *Swietenia macrophylla*, and *Tectona grandis*.

The main concerns in producing and harvesting timber are equipment limitations, the hazard of erosion, and plant competition. The very stony texture of the Tolonier soil limits the use of equipment. Minimizing the risk of erosion is essential in harvesting timber. After harvesting, reforestation must be carefully managed to reduce competition from undesirable understory plants. If the planting site is not adequately prepared, such competition can prevent or prolong natural or artificial reestablishment of trees. Hand planting of nursery stock usually is necessary to establish or improve a stand.

319—Tolonier-Dolen association, 60 to 100 percent slopes. This map unit is on uplands. Slopes generally are concave and are complex. Areas are irregular in shape and are 5 to 50 hectares in size. The vegetation is mainly mixed forest. Elevation is 6 to 600 meters. The mean annual rainfall is about 450 to 650 centimeters, and the mean annual air temperature is about 25 to 27 degrees C.

This unit is about 45 percent Tolonier very stony clay loam and 30 percent Dolen cobbly silt loam.

Included in this unit are small areas of Dolekei and Fomseng soils. Also included are small areas of rock outcroppings and Tolonier and Dolen soils that have slopes of more than 100 percent. Included areas make up about 25 percent of the total hectarage. The percentage varies from one area to another.

The Tolonier soil is very deep and well drained. It formed in residuum and colluvium derived from basic igneous rock. Typically, the upper 10 centimeters of the surface layer is dark brown very stony clay loam and the lower 15 centimeters is dark brown very stony silty clay loam. The upper 20 centimeters of the subsoil is dark yellowish brown stony clay loam, and the lower 50 centimeters is dark brown extremely stony silty clay. The substratum to a depth of 180 centimeters or more is brown and strong brown extremely stony clay loam.

Permeability of the Tolonier soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 150 centimeters or more. Runoff is rapid, and the hazard of water erosion is very high.

The Dolen soil is very deep and well drained. It formed in residuum and colluvium derived from basic igneous rock. Typically, the surface layer is dark brown cobbly silt loam 5 centimeters thick. The upper 38 centimeters of the subsoil is dark yellowish brown silty clay loam, and the lower 74 centimeters is yellowish brown silty clay loam. The substratum to a depth of 200 centimeters or more is dark brown stony silty clay loam.

Permeability of the Dolen soil is moderately rapid. Available water capacity is high. Effective rooting depth is 150 centimeters or more. Runoff is rapid, and the hazard of water erosion is very high.

This unit is used as woodland and watershed and for wildlife habitat.

This unit is poorly suited to use as woodland because of the very high hazard of erosion and equipment limitations as a result of slope and stoniness.

320—Typic Troporthents-Urban land complex, 0 to 1 percent slopes. This unit consists mainly of smooth areas filled with crushed coral, coral sand, mineral clayey soil material, and basalt gravel. Areas are irregular in shape and are 1 to 40 hectares in size. The vegetation generally consists of grasses and vines, but it varies depending on the material in the substratum, degree of compaction, and depth to the water table. Elevation is sea level to 30 meters. The mean annual rainfall is about 450 centimeters, and the mean annual air temperature is about 27 degrees C.

This unit is about 50 percent Typic Troporthents and 30 percent Urban land.

Included in this unit are small areas of Ngedebus, Rakied, Umpump, and Mesei Variant soils. Included areas make up about 20 percent of the total hectarage. The percentage varies from one area to another.

The surface layer of Typic Troporthents is compacted, crushed coral about 100 centimeters thick. The underlying material is variable. It is coral sand, organic deposits, clayey mineral soil material, coral bedrock, or hard basalt. Depth to the underlying material ranges from 50 to 300 centimeters.

Permeability of the Typic Troporthents is slow to moderately rapid. Available water capacity generally is low. The effective rooting depth ranges from 0 to 150 centimeters, depending on the compaction of the soils and depth to the water table. The water table is between depths of 50 and 150 centimeters. Runoff is slow, and the hazard of water erosion is slight.

Urban land consists of areas covered with homes and other urban structures.

This unit is used for homesite and urban development.

This unit is suited to homesite and urban development. Septic tank absorption fields generally do not function properly; therefore, sewers and sewage treatment facilities should be used.

321—Umpump silty clay loam, 2 to 8 percent slopes. This moderately deep, moderately well drained soil is on old lava flows on uplands. It formed in residuum derived from basic igneous rock. Areas are irregular in shape and are 2 to 20 hectares in size. The vegetation is mainly mixed forest. Elevation is 35 to 200 meters. The mean annual rainfall is about 450 to 550 centimeters, and the mean annual air temperature is about 27 degrees C.

Typically, the surface layer is dark yellowish brown silty clay loam 13 centimeters thick. The upper 25 centimeters of the subsoil is strong brown silty clay loam, and the lower 32 centimeters is red gravelly silty clay that has strong brown mottles. Highly weathered bedrock is at a depth of 70 centimeters. Depth to bedrock ranges from 50 to 100 centimeters.

Included in this unit are small areas of Dolekei and Fomseng soils. Also included are small areas of poorly drained soils that are mainly in depressional areas and small areas of an Umpump soil that has stones and cobbles on the surface. Included areas make up about 20 percent of the total hectarage. The percentage varies from one area to another.

Permeability of the Umpump soil is moderate. Available water capacity is moderate. Effective rooting depth is 50 to 100 centimeters. Runoff is slow, and the hazard of water erosion is slight. A high water table fluctuates between depths of 60 and 100 centimeters throughout the year.

This unit is used for subsistence farming, black pepper production, woodland, and homesite development.

This unit is suited to subsistence farming. Crops that are climatically adapted, are tolerant of acidity, and are shallow-rooted can be grown successfully if the soil is drained. Examples of such crops are bananas, kava, tapioca, and sweet potatoes. The organic matter content of the soil should be maintained for sustained yields. This can be accomplished by the use of plant residue, mulch, and compost. Burning to clear land and control weeds destroys needed organic matter, and it reduces soil fertility.

This unit is suited to black pepper production. It is limited mainly by wetness and low soil fertility. Wetness can be reduced by installing drainage ditches. The fertility of the soil can be improved by the use of commercial fertilizer, lime, and additional organic matter. A cover crop planted between the pepper plants helps to maintain the organic matter content of the soil.

This unit is suited to woodland species such as *Adenanthera pavonina*, *Campnosperma brevipetiolata*, *Elaeocarpus carolinensis*, and *Barringtonia racemosa*. Introduced species suitable for planting are *Eucalyptus saligna*, *Tectona grandis*, and *Swietenia macrophylla*.

The main concerns in producing and harvesting timber are seedling mortality and plant competition. After harvesting, reforestation must be carefully managed to reduce competition from undesirable understory plants. If the planting site is not adequately prepared, such competition can prevent or prolong natural or artificial reestablishment of trees. Hand planting of nursery stock usually is necessary to establish or improve a stand.

This unit is suited to homesite development. The main limitation is wetness, which can be greatly reduced by installing drainage ditches. Septic tank absorption fields do not function properly; therefore, sewers and sewage treatment facilities should be used.

322—Umpump gravelly sandy clay loam, 2 to 15 percent slopes. This moderately deep, moderately well drained soil is on old lava flows on uplands. It formed in residuum derived from basic igneous rock. Areas are irregular in shape and are 2 to 20 hectares in size. The vegetation is mainly mixed forest and grassland. Elevation is 5 to 200 meters. The mean annual rainfall is about 450 to 500 centimeters, and the mean annual air temperature is about 27 degrees C.

Typically, the surface layer is dark yellowish brown gravelly sandy clay loam 13 centimeters thick. The upper 28 centimeters of the subsoil is strong brown gravelly silty clay loam, and the lower 25 centimeters is red gravelly silty clay that has strong brown mottles. Highly weathered bedrock is at a depth of 66 centimeters. Depth to bedrock ranges from 50 to 100 centimeters.

Included in this unit are small areas of nearly level Rakied soils and Fomseng soils on the steeper side slopes. Also included are small areas of Umpump soils that have a very gravelly clay loam or silty clay loam surface layer. Included areas make up about 30 percent of the total hectarage. The percentage varies from one area to another.

Permeability of the Umpump soil is moderate. Available water capacity is moderate. Effective rooting depth is 50 to 100 centimeters. Runoff is slow to medium, and the hazard of water erosion is slight to moderate. A high water table fluctuates between depths of 60 and 100 centimeters throughout the year.

This unit is used for subsistence farming, black pepper production, and homesite development.

This unit is suited to subsistence farming. Crops that are climatically adapted, are tolerant of acidity, and are shallow-rooted can be grown successfully if the soil is drained. Examples of such crops are bananas, kava, tapioca, and sweet potatoes. The organic matter content of the soil should be maintained for sustained yields. This can be accomplished by the use of plant residue, mulch, and compost. The use of cover crops in areas not cultivated and between rows of crops also helps to maintain the organic matter content and to control erosion on the steeper slopes. Burning to clear land and control weeds destroys needed organic matter, and it reduces soil fertility.

This unit is suited to black pepper production. It is limited mainly by the fluctuating high water table and low soil fertility. The water table can be lowered by installing drainage ditches. The fertility of the soil can be improved by the use of commercial fertilizer, lime, and additional organic matter. A cover crop planted between the pepper plants helps to maintain the organic matter content and to control erosion on the steeper slopes.

This unit is suited to homesite development. The main limitation is wetness and slope. Wetness can be reduced by installing drainage ditches. Septic tank absorption fields do not function properly; therefore, sewers and sewage treatment facilities should be used. Erosion is a hazard in the steeper areas. Only the part of the site that is used for construction should be disturbed.

323—Umpump gravelly silty clay loam, 2 to 8 percent slopes. This moderately deep, moderately well drained soil is on old lava flows on uplands. It formed in residuum derived from highly weathered basic igneous rock. Areas are irregular in shape and are 2 to 20 hectares in size. The vegetation in areas not cultivated is mainly mixed forest and grassland. Elevation is 5 to 200 meters. The mean annual rainfall is about 450 to 500 centimeters, and the mean annual air temperature is about 27 degrees C.

Typically, the surface layer is dark yellowish brown gravelly silty clay loam 13 centimeters thick. The upper 28 centimeters of the subsoil is strong brown gravelly silty clay loam, and the lower 25 centimeters is red gravelly silty clay that has strong brown mottles. Highly weathered bedrock is at a depth of 66 centimeters. Depth to bedrock ranges from 50 to 100 centimeters.

Included in this unit are small areas of Rakied and Fomseng soils. Also included are small areas of Umpump very gravelly clay loam. Included areas make up about 20 percent of the total hectarage. The percentage varies from one area to another.

Permeability of the Umpump soil is moderate. Available water capacity is moderate. Effective rooting depth is 50 to 100 centimeters. Runoff is slow, and the hazard of water erosion is slight. A high water table fluctuates between depths of 60 and 100 centimeters throughout the year.

This unit is used for subsistence farming, black pepper production, and homesite development.

This unit is suited to subsistence farming. Crops that are climatically adapted, are tolerant of acidity, and are shallow-rooted can be grown successfully if the soil is drained. Examples of such crops are bananas, kava, tapioca, and sweet potatoes. The organic matter content of the soil should be maintained for sustained yields. This can be accomplished by the use of plant residue, mulch, and compost. Burning to clear land and control weeds destroys needed organic matter, and it reduces soil fertility.

This unit is suited to black pepper production. It is limited mainly by the fluctuating high water table and low soil fertility. The water table can be lowered by installing drainage ditches. The fertility of the soil can be improved by the use of commercial fertilizer, lime, and additional organic matter.

This unit is suited to homesite development. The main limitation is wetness, which can be reduced by installing drainage ditches. Septic tank absorption fields do not function properly; therefore, sewers and sewage treatment facilities should be used.

324—Umpump very gravelly clay loam, 2 to 8 percent slopes. This moderately deep, moderately well drained soil is on old lava flows on uplands. It formed in residuum derived from basic igneous rock. Areas are irregular in shape and are 2 to 20 hectares in size. The vegetation is mainly mixed forest and grassland. Elevation is 5 to 200 meters. The mean annual rainfall is about 450 to 550 centimeters, and the mean annual air temperature is about 27 degrees C.

Typically, the surface layer is dark yellowish brown very gravelly clay loam 13 centimeters thick. The upper 28 centimeters of the subsoil is strong brown gravelly clay loam, and the lower 25 centimeters is red silty clay and has strong brown mottles. Highly weathered bedrock is at a depth of 66 centimeters. Depth to bedrock ranges from 50 to 100 centimeters.

Included in this unit are small areas of Rakied soils and soils that are similar to this Umpump soil but are somewhat poorly drained and have a water table between depths of 25 and 60 centimeters. Also included are small areas of soils that are similar to this Umpump soil but have an extremely gravelly surface layer. Included areas make up about 30 percent of the total hectarage. The percentage varies from one area to another.

Permeability of the Umpump soil is moderate. Available water capacity is low to a depth of 13 centimeters and moderate below this depth. Effective rooting depth is 50 to 100 centimeters. Runoff is slow, and the hazard of water erosion is slight. A high water table fluctuates between depths of 60 and 100 centimeters throughout the year.

This unit is used for subsistence farming and homesite development.

This unit is suited to subsistence farming. Crops that are climatically adapted, are tolerant of acidity, and are shallow-rooted can be grown successfully if the soil is drained. Examples of such crops are bananas, kava, tapioca, and sweet potatoes. The organic matter content of the soil should be maintained for sustained yields. This can be accomplished by the use of plant residue, mulch, compost, and cover crops. Burning to clear land and control weeds destroys needed organic matter, and it reduces soil fertility.

Vegetable gardens are difficult to establish on this unit because of the low available water capacity of the surface layer. This limitation can be overcome by mixing the surface layer with compost before planting and by mulching.

This unit is suited to black pepper production. It is limited mainly by the fluctuating high water table and low soil fertility. The water table can be lowered by installing drainage ditches. The fertility of the soil can be improved by the use of commercial fertilizer, lime, and additional organic matter. A cover crop planted between the pepper plants helps to maintain the organic matter content of the soil.

This unit is suited to homesite development. The main limitation is wetness, which can be greatly reduced by installing drainage ditches. Septic tank absorption fields do not function properly; therefore, sewers and sewage treatment facilities should be used.

325—Umpump-Urban land complex, 2 to 8 percent slopes. This map unit is on old, highly weathered lava flows on uplands. Areas are irregular in shape and are 2 to 20 hectares in size. Elevation is 5 to 75 meters. The mean annual rainfall is about 450 centimeters, and the mean annual air temperature is about 27 degrees C.

This unit is 45 percent Umpump gravelly silty clay loam and 35 percent Urban land. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Rakied soils. Also included are small areas of soils that are similar to the Umpump soil but have stones on the surface. Included areas make up about 20 percent of the total hectarage. The percentage varies from one area to another.

The Umpump soil is moderately deep and moderately well drained. It formed in residuum derived from basic igneous rock. Typically, the surface layer is dark yellowish brown gravelly silty clay loam 13 centimeters thick. The upper 28 centimeters of the subsoil is strong brown gravelly silty clay loam, and the lower 25 centimeters is red gravelly silty clay loam that has strong brown mottles. Highly weathered bedrock is at a depth of 66 centimeters. Depth to bedrock ranges from 50 to 100 centimeters.

Permeability of the Umpump soil is moderate. Available water capacity is moderate. Effective rooting depth is 50 to 100 centimeters. Runoff is slow, and the hazard of water erosion is slight. A high water table is at a depth of 60 to 100 centimeters throughout the year.

The Urban land areas of this unit are mostly covered with buildings, roads, or crushed coral fill.

This unit is used for urban and homesite development.

This unit is suited to urban and homesite development. The main limitation is wetness. Septic tank absorption fields do not function properly; therefore, sewers and sewage treatment facilities should be used. Drainage ditches and storm drains are needed to remove excess surface runoff.

326—Wahrekdam very gravelly sandy loam, 2 to 8 percent slopes. This moderately deep, well drained soil is on uplands and ridgetops. It formed in residuum derived dominantly from basic igneous rock. Areas are irregular in shape and are 4 to 20 hectares in size. The vegetation is mainly mixed forest. Elevation is 20 to 200 meters. The mean annual rainfall is about 450 to 500 centimeters, and the mean annual air temperature is about 27 degrees C.

Typically, the surface layer is dark brown very gravelly sandy loam 20 centimeters thick. The upper 23 centimeters of the subsoil is strong brown very gravelly sandy clay loam, and the lower 32 centimeters is strong brown very cobbly clay loam over yellowish red rind that crushes to silt loam. Hard basalt is at a depth of 75 centimeters. Depth to basalt ranges from 50 to 100 centimeters.

Included in this unit are small areas of Umpump and Mesei Variant soils. Also included are small areas of soils that are similar to this Wahrekdam soil but are shallower, have stones on the surface, or are slightly steeper. Included areas make up about 25 percent of the total hectarage. The percentage varies from one area to another.

Permeability of the Wahrekdam soil is moderately rapid. Available water capacity is low. Effective rooting depth is 50 to 100 centimeters. Runoff is slow, and the hazard of water erosion is slight.

This unit is used for subsistence farming, woodland, and wildlife habitat.

This unit is suited to adapted crops such as bananas, breadfruit, and coconuts. It is limited mainly by low soil fertility and low available water capacity. A continuing supply of organic matter from fallen leaves and branches or from compost is essential for sustained crop yields. Burning the vegetation on this soil destroys needed organic matter, and it results in a decrease in soil fertility. Copra production can be increased by fertilizing with potassium and coral sand. Wood ash is a fair source of potassium.

This unit is suited to the production of adapted woodland species such as *Campnosperma brevipetiolata*, *Elaeocarpus carolinensis* and *Parinarium glaberrium*. Introduced species suitable for planting are *Eucalyptus saligna*, *Swietenia macrophylla*, and *Tectona grandis*.

The main concerns in producing and harvesting timber are seedling mortality, the hazard of windthrow, and plant competition. Hand planting of nursery stock usually is necessary to establish or improve a stand. Trees commonly are subject to windthrow during periods when the soil is excessively wet and winds are strong. After harvesting, reforestation must be carefully managed to reduce competition from undesirable understory plants. If the site is not adequately prepared, competition from undesirable plants can prevent or prolong natural or artificial reestablishment of trees.

use and management of the soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops, as woodland, and as sites for buildings, sanitary facilities, roads, and parks and other recreation facilities. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

crops

General management needed for crops is suggested in this section. The crops best suited to the soils, including some not commonly grown in the survey area, are identified. Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed soil map units."

The potential of the soils in the survey area for increased production of food is fair to good, partly because many areas are not being used for crops at the present time. Crop yields could also be increased by extending the latest crop production technology to all the land in the survey area that is suitable for use as cropland.

Many factors, such as low soil fertility, wetness, shallow rooting depth, steepness of slope, stoniness, and erosion, limit crop production in the area. Not all the soils have the same limitations. Some soils are well suited to certain crops and are poorly suited or moderately suited to other crops, depending on the specific needs or sensitivities of any particular crop. For example, because of wetness the Inkosr soils are well suited to wetland taro but are poorly suited to coconuts. Table 2 lists the suitability of many crops to specified map units in the area.

Many soils in this survey area need lime or fertilizer, or both. Additions of lime and fertilizer should be based on the results of soil tests and on the needs of the crop grown. Only general suggestions for applying lime and fertilizer are given in this survey. The latest information and suggestions for growing crops can be obtained from the Ponape State Agriculture Station in Kolonia.

Two main crop management systems are discussed in this survey. One is commercial high level management that requires the use of machines and commercial fertilizers. The other is the more traditional system of subsistence farming that relies on hand labor and does not use commercial fertilizers. Some areas are best suited to commercial agriculture with high level management practices, and many other areas are best suited to subsistence farming. Part of the reason for this has to do with the history of agriculture and land use on Ponape.

Before World War II, during the Japanese administration, many areas of Ponape were cleared for the cultivation of crops such as sugarcane and sweet potatoes. Most of these areas were on the nearly level to gently sloping Rakied, Umpump, and Wahrekdam soils. After the war these cultivated areas were abandoned and were subsequently overgrown with grasses and weedy plants. Many of these open areas have been repeatedly burned to control the weeds. The results of clearing, heavy cropping, and then burning are areas of soils that have low organic matter content, low reaction, and low fertility. These soils are not well suited to subsistence farming, but they are suited to commercial farming. Crops such as vegetables and black pepper can be grown successfully if fertilizer and lime are applied. Many of these areas can also be improved by artificial drainage.

Subsistence farming is the main type of agriculture practiced on Ponape (*5*). Generally, this consists of growing crops such as bananas, breadfruit, coconuts, and mangoes intermingled with the native trees or with other planted crops such as tapioca, sugarcane, and pineapple. This cropping system is well suited to most upland areas that are not too steep because it does not require land clearing, machine cultivation, or use of commercial fertilizer.

The key to successful subsistence farming is maintaining the organic matter content of the soil. Soil fertility is low in most of the upland soils in the area. Most of the nutrients needed for plant growth in these soils are contained in the organic matter of the surface layer. If the surface layer is lost or partially lost through erosion or if the soils are cleared for cultivation, the organic matter content of the soils is reduced and therefore must be artificially maintained for sustained yields. This can be accomplished by adding plant residue, mulch, compost, animal manure, and fallen leaves and branches (*4*). Maintaining organic litter on the surface of the soils also reduces soil erosion and runoff.

Soil erosion is a major concern in areas where slopes are more than 15 percent. Practices such as minimum tillage, using terraces and diversions, contouring, and using cropping systems that rotate grass or close-growing crops with row crops help to control erosion. Growing row crops in areas where slopes are more than 30 percent is not a suitable practice because of the high or very high hazard of erosion in those areas.

Most of the bottom land soils in the area, such as the Nansepsep and Inkosr soils, are poorly suited to row crops because of poor drainage and a hazard of flooding. Row crops can be grown on the Nansepsep soils if artificial drainage is applied. The wetter Inkosr soils are better suited to wetland crops such as rice and wetland taro. Wet organic soils such as the Mesei Variant soils are poorly suited to artificial drainage because of subsidence. Mesei Variant soils can be used for wetland taro.

woodland management and productivity

Woodland makes up about 29,000 hectares, or 80 percent, of the survey area. Most of this area is mixed forest on steep mountains in the interior of the island. About 5,000 hectares is mangrove swamp forest. The soils in these areas produce trees of high quality if the woodland is properly managed. The potential for increased timber production is high.

The largest areas of woodland are on uplands in general soil map units 4 and 5 and in coastal swamps in unit 2, described in the section "General soil map units." The most common trees on the uplands that have potential for timber production are *Campnosperma brevipetiolata*, *Elaeocarpus carolinensis*, *Adenanthera pavonina*, and *Parinarium glaberrium*. Introduced species that are suitable for planting and that have the potential for increased timber production are *Eucalyptus saligna*, *Eucalyptus deglupta*, *Tectona grandis*, and *Swietenia macrophylla*.

The latest information and suggestions for planting and managing woodland can be obtained from the Ponape State Department of Forestry in Kolonia.

Table 3 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The species listed in the table are given by scientific name because the Ponapean or English common name is not available for all the species. In table 4, however, the scientific names are listed alphabetically and both the Ponapean and English common names are given if known.

In table 3, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or in equipment; and *severe* indicates a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree to which the soil affects the mortality of tree seedlings. Plant competition is not considered in the ratings. The ratings apply to seedlings from good stock that are properly planted during a period of sufficient rainfall. A rating of *slight* indicates that the expected mortality is less than 25 percent; *moderate*, 25 to 50 percent; and *severe*, more than 50 percent.

Ratings of *windthrow hazard* are based on soil characteristics that affect the development of tree roots and the ability of the soil to hold trees firmly. A rating of *slight* indicates that a few trees may be blown down by normal winds; *moderate*, that some trees will be blown down during periods of excessive soil wetness and strong winds; and *severe*, that many trees are blown down during periods of excessive soil wetness and moderate or strong winds.

Ratings of *plant competition* indicate the degree to which undesirable plants are expected to invade where there are openings in the tree canopy. The invading plants compete with native plants or planted seedlings. A rating of *slight* indicates little or no competition from other plants; *moderate* indicates that plant competition is expected to hinder the development of a fully stocked stand of desirable trees; *severe* indicates that plant competition is expected to prevent the establishment of a desirable stand unless the site is intensively prepared, weeded, or otherwise managed to control undesirable plants.

Common trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

Trees to plant are those that are suited to the soils and to commercial wood production.

recreation

The Island of Ponape has many areas of scenic, geologic, and historic interest. These areas are used for hiking, sightseeing, picnicking, and nature study and as wilderness. The soils that are best suited to these types of recreation are in general map units 4 and 5, described in the section "General soil map units." These map units are characterized by steep terrain, thick and lush vegetation, exposed rock formations, and many streams.

The soils of the survey area are rated in table 5 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 5, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 5 can be supplemented by other information in this survey; for example, interpretations for septic tank absorption fields in table 7 and interpretations for dwellings without basements and for local roads and streets in table 6.

Camp areas require site preparation such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock should be considered.

Paths and trails for hiking should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 150 to 180 centimeters. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or *for testing and analysis by personnel experienced in the design and construction of engineering works.*

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 150 to 180 centimeters of the surface, soil wetness, depth to a high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

building site development

Table 6 shows the degree and kind of soil limitations that affect shallow excavations, dwellings without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 150 to 180 centimeters for graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock or a very firm dense layer; stone content; soil texture; and slope. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 150 to 180 centimeters are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 180 centimeters. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, and depth to a high water table affect the traffic supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock, the available water capacity in the upper 100 centimeters, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

sanitary facilities

Table 7 shows the degree and the kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 7 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 60 and 180 centimeters is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock, and flooding affect absorption of the effluent. Large stones and bedrock interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 120 centimeters below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to effectively filter the effluent. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 60 to 120 centimeters. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 7 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 30 to 60 centimeters of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope and bedrock can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 7 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 180 centimeters. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

construction materials

Table 8 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil.

They are rated as a probable or improbable source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 150 to 180 centimeters.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 180 centimeters high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 150 to 180 centimeters. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 150 centimeters of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 90 centimeters. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 30 to 90 centimeters. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 30 centimeters. They may have layers of suitable material, but the material is less than 90 centimeters thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 8, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 90 centimeters thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 100 centimeters of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 100 centimeters. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 50 to 100 centimeters of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 50 centimeters of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

water management

Table 9 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 150 centimeters. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 6 meters high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 150 centimeters. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 150 centimeters of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; and subsidence of organic layers. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

soil properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

engineering index properties

Table 10 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 150 to 180 centimeters.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil series and their morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains particles coarser than sand, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (*1*). The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 76 millimeters in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, SP-SM.

Rock fragments larger than 76 millimeters in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 76 millimeters in diameter based on an oven-dry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

physical and chemical properties

Table 11 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in centimeters of water per centimeter of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals and water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.02 to 0.69. The higher the value the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period.

Organic matter is the plant and animal residue in the soil at various stages of decomposition.

In table 11, the estimated content of organic matter of the plow layer is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

soil and water features

Table 12 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall and water in swamps and marshes are not considered flooding.

Table 12 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs, on the average, no more than once in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May, and January-December means that flooding can occur in any month.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table is the highest level of a saturated zone in the soil in most years. The depth to a high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 12 are the depth to the high water table; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 12.

Only saturated zones within a depth of about 180 centimeters are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Depth to bedrock is given if bedrock is within a depth of 150 centimeters. The depth is based on many soil borings and on observations during soil mapping. The rock is specified as either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Subsidence is the settlement of organic soils or of saturated mineral soils of very low density. Subsidence results from either desiccation and shrinkage or oxidation of organic material, or both, following drainage. Subsidence takes place gradually, usually over a period of several years. Table 12 shows the expected initial subsidence, which usually is a result of drainage, and annual subsidence, which usually is a result of oxidation.

Not shown in the table is subsidence caused by an imposed surface load or by the withdrawal of ground water throughout an extensive area as a result of lowering the water table.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*8*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. In table 13, the soils of the survey area are classified according to the system. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Entisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquent (*Aqu*, meaning water, plus *ent*, from Entisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Tropaquents (*Trop*, meaning tropical temperature regime, plus *aquent*, the suborder of the Entisols that have an aquic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Tropaquents.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine, mixed, nonacid, isohyperthermic Typic Tropaquents.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

soil series and their morphology

In this section, each soil series or variant recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the Soil Survey Manual (*7*). Many of the technical terms used in the descriptions are defined in Soil Taxonomy (*8*). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed soil map units."

Dolekei series

The Dolekei series consists of moderately deep, well drained soils on uplands. These soils formed in material weathered from basic igneous rock. Slope is 15 to 100 percent. The mean annual rainfall is about 470 centimeters, and the mean annual temperature is about 26 degrees C.

Taxonomic class: Fine, mixed, isohyperthermic Typic Dystropepts.

Typical pedon: Dolekei silty clay loam; on a 40-percent, convex, complex slope in an area of agricultural forest. When described (3/28/79), the soil was moist throughout. Colors are for moist soil. All textures are apparent field textures.

A1—0 to 8 centimeters; dark brown (7.5YR 3/2) silty clay loam; moderate very fine and fine subangular blocky structure; very friable, slightly sticky and slightly plastic; many very fine, fine, medium, and coarse roots; common very fine tubular and interstitial pores; about 5 percent pebbles and 5 percent small hard basalt cobbles; strongly acid (pH 5.3 in 1:1 water); abrupt smooth boundary. (8 to 28 centimeters thick)

B2—8 to 36 centimeters; dark yellowish brown (10YR 4/4) silty clay loam; moderate medium subangular blocky structure; friable, slightly sticky and plastic; few very fine, fine, and medium roots; common very fine and fine tubular pores; about 5 percent pebbles and 5 percent hard basalt cobbles; strongly acid (pH 5.4 in 1:1 water); gradual wavy boundary. (23 to 40 centimeters thick)

C1—36 to 74 centimeters; yellowish brown (10YR 5/4) silty clay loam with a dark grayish brown (2.5Y 4/2) lithochromic saprolitic intrusion 20 centimeters thick at about 60 degrees of tilt; massive; friable, slightly sticky and slightly plastic; common fine and medium roots; many very fine tubular pores; strongly acid (pH 5.4 in 1:1 water); gradual irregular boundary. (19 to 38 centimeters thick)

C2r—74 to 104 centimeters; yellowish brown (10YR 5/4) highly weathered saprolitic basic igneous rock that crushes to silt loam; many manganese and iron stains in fractures 3 to 7 centimeters apart and less than 1 millimeter wide; strongly acid (pH 5.4 in 1:1 water).

Type location: Island of Ponape, Federated States of Micronesia; about 800 meters east of Dahu Sokele bridge, then 215 meters south; lat. 6°57'4.1" N. and long. 158°15'6.4" E.

Range in characteristics: From 0 to 20 percent of the surface is covered with cobbles. The depth to paralithic contact ranges from 50 to 100 centimeters. Reaction in 1:1 water ranges from very strongly acid to medium acid.

The A horizon has moist color of 10YR 3/3, 3/4, 4/3, or 4/6 or of 7.5YR 3/2 or 3/4. It is silty clay loam or clay loam. The horizon is 0 to 20 percent cobbles.

The B horizon has color of 10YR 4/4, 4/6, 5/6, or 5/8. It is heavy clay loam, silty clay, or clay. The horizon is 5 to 20 percent cobbles and 5 to 15 percent pebbles.

The C horizon is silt loam, loam, or silty clay loam.

Dolen series

The Dolen series consists of very deep, well drained soils on uplands. These soils formed in residuum and colluvium derived from basic igneous rock. Slope is 6 to 100 percent. The mean annual rainfall is about 370 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Very fine, mixed, isohyperthermic Typic Dystropepts.

Typical pedon: Dolen cobbly silt loam; on a 48-percent, convex slope in an area of agricultural forest. When described (2/15/79), the soil was moist throughout. Colors are for moist soil. All textures are apparent field textures.

A1—0 to 5 centimeters; dark brown (7.5YR 3/2) cobbly silt loam; strong fine and medium granular structure; very friable, slightly sticky and slightly plastic; many fine and medium roots and common coarse roots; many very fine and fine interstitial pores and common very fine tubular pores; about 20 percent hard basalt cobbles; slightly acid (pH 6.4 in 1:1 water); clear wavy boundary. (5 to 30 centimeters thick)

B21—5 to 20 centimeters; dark yellowish brown (10YR 4/4) silty clay loam; moderate fine subangular blocky structure parting to strong fine and medium granular; friable, slightly sticky and plastic; many fine and medium roots; many very fine and fine tubular and interstitial pores; 10 percent cobbles; medium acid (pH 5.8 in 1:1 water); gradual wavy boundary. (13 to 25 centimeters thick)

B22—20 to 43 centimeters; dark yellowish brown (10YR 4/4) silty clay loam; moderate medium subangular blocky structure parting to strong very fine angular blocky; firm, slightly sticky and plastic; common fine and medium roots; common very fine and fine tubular and interstitial pores; 5 percent highly weathered pebbles; medium acid (pH 5.6 in 1:1 water); gradual wavy boundary. (8 to 30 centimeters thick)

B23—43 to 117 centimeters; yellowish brown (10YR 5/4) silty clay loam; moderate coarse subangular blocky structure parting to moderate fine and medium granular; firm, slightly sticky and plastic; common fine roots in upper part, decreasing to few in lower part; common very fine and fine tubular and interstitial pores; 5 percent highly weathered pebbles; strongly acid (pH 5.5 in 1:1 water); abrupt irregular boundary. (50 to 75 centimeters thick)

C—117 to 200 centimeters; dark brown (7.5YR 4/2) stony silty clay loam; weak medium and coarse subangular blocky structure; few very fine and medium roots; many very fine tubular pores; 35 percent basalt cobbles and stones; strongly acid (pH 5.5 in 1:1 water).

Type location: Sokehs Island, Ponape State, Federated States of Micronesia; about 600 meters from the beginning of the old Japanese road on the east side of Sokehs Island, at road cut; lat. 6°57'41" N. and long. 158°12'38" E.

Range in characteristics: Depth to highly weathered basic igneous rock ranges from 150 centimeters to more than 200 centimeters. The thickness of the solum ranges from 70 to 125 centimeters.

The A horizon has moist color of 7.5YR 3/2, 3/4, or 4/4 or of 10YR 3/3, 3/4, or 4/4. The apparent field texture is silt loam or silty clay loam. The horizon is 0 to 25 percent cobbles and 0 to 5 percent stones. The reaction in 1:1 water ranges from slightly acid to strongly acid.

The B horizon has moist color of 7.5YR 4/4 or 4/6 or of 10YR 4/4, 4/6, or 5/4. The apparent field texture is silty clay loam, clay loam, silty clay, or clay. The horizon is 0 to 20 percent cobbles and 0 to 5 percent pebbles. The reaction in 1:1 water is medium acid or strongly acid.

The C horizon has moist color of 7.5YR 4/2, 4/4, or 4/6 or of 10YR 4/4 or 5/6. The apparent field texture is silty clay loam or silt loam. The horizon is 0 to 50 percent cobbles and stones and 0 to 10 percent pebbles.

Fomseng series

The Fomseng series consists of shallow, well drained soils on uplands. These soils formed in residuum derived from basic igneous rock. Slope is 15 to 100 percent. The mean annual rainfall is about 525 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Clayey, mixed, isohyperthermic, shallow Typic Humitropepts.

Typical pedon: Fomseng gravelly silty clay loam; on a 35-percent, convex slope in an area of agricultural forest. When described (11/3/80), the soil was moist throughout. Colors are for moist soil. All textures are apparent field textures.

A11—0 to 5 centimeters; dark brown (10YR 3/3) gravelly silty clay loam; strong fine subangular blocky structure; friable, slightly sticky and slightly plastic; common very fine and fine roots; common fine and medium tubular and interstitial pores; about 20 percent pebbles; slightly acid (pH 6.5 in 1:1 water); abrupt wavy boundary. (4 to 7 centimeters thick)

A12—5 to 12 centimeters; brown (10YR 4/3) silty clay loam; strong fine and medium subangular blocky structure; friable, slightly sticky and slightly plastic; common fine roots; common fine tubular pores; medium acid (pH 6.0 in 1:1 water); clear wavy boundary. (5 to 8 centimeters thick)

B2—12 to 35 centimeters; dark yellowish brown (10YR 4/4) silty clay loam; moderate fine and medium subangular blocky structure; friable, slightly sticky and slightly plastic; few fine roots; common fine and medium tubular pores; strongly acid (pH 5.5 in 1:1 water); gradual wavy boundary. (15 to 25 centimeters thick)

C1—35 to 45 centimeters; dark yellowish brown (10YR 4/6) silty clay loam; moderate medium and coarse angular blocky structure; friable, slightly sticky and slightly plastic; few fine roots; common fine tubular pores; strongly acid (pH 5.5 in 1:1 water); abrupt wavy boundary. (0 to 12 centimeters thick)

C2r—45 to 150 centimeters; highly weathered basalt; can be dug with a spade; roots penetrate only along fracture planes.

Type location: Island of Kosrae, Federated States of Micronesia; about 1 kilometer up the Fomseng farm road, on a cutbank; lat. 5°20'18" N. and long. 163°0'19" E.

Range in characteristics: The depth to paralithic contact ranges from 25 to 50 centimeters.

The A horizon has moist color of 10YR 3/2, 3/3, or 4/3 or of 7.5YR 4/4. It is silty clay loam or clay loam and has 0 to 10 percent cobbles and 0 to 25 percent pebbles. The reaction in 1:1 water ranges from strongly acid to slightly acid.

The B horizon has moist color of 10YR 3/4, 4/4, or 4/6 or of 7.5YR 4/6. It is silty clay loam, clay loam, or silty clay and has 0 to 20 percent cobbles and 0 to 10 percent pebbles. The reaction in 1:1 water is strongly acid or medium acid.

The C horizon has moist color of 10YR 4/6 or 5/6 or of 7.5YR 5/6. It is silty clay loam or clay loam and has 0 to 30 percent saprolitic cobbles and 0 to 20 percent saprolitic pebbles.

Fomseng Variant

The Fomseng Variant consists of very shallow, well drained soils on uplands. These soils formed in residuum derived from basic igneous rock. Slope is 15 to 60 percent. The mean annual rainfall is about 525 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Clayey, mixed, acid, isohyperthermic, shallow Typic Troporthents.

Typical pedon: Fomseng Variant silt loam; on a 20-percent, convex slope in an area of deteriorated savannah. When described (3/7/79), the soil was moist throughout. Colors are for moist soil. All textures are apparent field textures.

A1—0 to 10 centimeters; dark yellowish brown (10YR 3/4) silt loam; strong fine and medium granular structure; friable, slightly sticky and slightly plastic; common very fine and fine roots; common very fine and fine tubular and interstitial pores; about 5 percent pebbles; very strongly acid (pH 5.0 in 1:1 water); clear wavy boundary. (5 to 12 centimeters thick)

B2—10 to 17 centimeters; strong brown (7.5YR 4/6) silty clay loam; moderate medium angular blocky structure; firm, sticky and slightly plastic; few very fine and fine roots; common very fine tubular pores; about 10 percent saprolitic pebbles; strongly acid (pH 5.1 in 1:1 water); abrupt wavy boundary. (5 to 13 centimeters thick)

Cr—17 to 100 centimeters; highly weathered basalt; can be dug with a spade; crushes to silt loam; common thin random fractures about 5 to 10 centimeters apart; black manganese stains in fractures and vesicular pores; roots penetrate only along fracture planes.

Type location: Island of Ponape, Federated States of Micronesia; about 120 meters north of Pwisenmalek rock and 10 meters west of road; lat. 6°54'19" N. and long. 158°9'55" E.

Range in characteristics: The depth to paralithic contact ranges from 10 to 25 centimeters. The reaction in 1:1 water ranges from very strongly acid to strongly acid in all horizons.

The A horizon has moist color of 10YR 3/3 or 3/4 or of 7.5YR 3/2 or 4/2. It is silt loam or loam and has 0 to 10 percent gravel.

The B horizon has moist color of 7.5YR 4/4 or 4/6. It is silty clay loam or clay loam and has 5 to 15 percent gravel.

Inkosr series

The Inkosr series consists of very deep, poorly drained soils on bottom lands. These soils formed in alluvium derived dominantly from basic igneous rock. Slope is 0 to 2 percent. The mean annual rainfall is about 450 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Fine, mixed, nonacid, isohyperthermic Typic Tropaquepts.

Typical pedon: Inkosr silty clay loam; in an area of swamp forest. When described (2/3/80), the soil was moist to a depth of 25 centimeters and saturated below. Colors are for moist soil. All textures are apparent field textures.

A1—0 to 17 centimeters; dark yellowish brown (10YR 3/4) silty clay loam; strong fine subangular blocky structure; friable, slightly sticky and slightly plastic; many fine and medium roots; common fine tubular and interstitial pores; medium acid (pH 6.0 in 1:1 water); abrupt smooth boundary. (10 to 25 centimeters thick)

B1—17 to 27 centimeters; dark brown (10YR 3/3) silty clay loam; many medium distinct strong brown (7.5YR 5/8) mottles; strong fine subangular blocky structure; friable, slightly sticky and slightly plastic; common fine and medium roots; common fine tubular pores; medium acid (pH 6.0 in 1:1 water); clear smooth boundary. (7 to 15 centimeters thick)

B2—27 to 45 centimeters; dark gray (10YR 4/1) silty clay loam; many medium distinct yellowish red (5YR 5/8) mottles; moderate fine and medium subangular blocky structure; friable, sticky and slightly plastic; few fine and medium roots; common fine tubular pores; medium acid (pH 6.0 in 1:1 water); clear wavy boundary. (13 to 20 centimeters thick)

C1g—45 to 75 centimeters; dark greenish gray (5GY 4/1) silty clay loam; massive; sticky and slightly plastic; common fine tubular pores; slightly acid (pH 6.5 in 1:1 water); gradual wavy boundary. (20 to 100 centimeters thick)

C2g—75 to 150 centimeters; dark greenish gray (5G 4/1) silty clay loam; massive; sticky and slightly plastic; common fine tubular pores; about 10 percent hard rounded basalt pebbles; slightly acid (pH 6.5 in 1:1 water).

Type location: Island of Kosrae, Federated States of Micronesia; about 300 meters north of the high school boundary in Tofol and 10 meters west of the main road; lat. 5°19'47" N. and long. 163°0'28" E.

Range in characteristics: Depth to the fluctuating water table ranges from 15 to 60 centimeters, and depth to the gleyed C horizon ranges from 30 to 60 centimeters. The solum is strongly acid or medium acid.

The A horizon has moist color of 10YR 2/2, 3/2, 3/3, or 3/4. It is silty clay loam or sandy clay loam and has 0 to 30 percent pebbles.

The upper part of the B horizon has moist color of 10YR 3/3 or 4/3 and has mottles of 7.5YR 4/6, 5/6, or 5/8. The lower part has moist color of 10YR 4/1 or 4/2 and has mottles of 5YR 5/6 or 5/8 or of 7.5YR 4/6 or 5/8. It is sandy clay loam, clay loam, or silty clay loam and has 0 to 30 percent pebbles.

The C horizon has moist color of 5G 4/1, 5GY 4/1, or 5Y 5/2. It is silty clay loam, clay loam, silty clay, or clay and has 0 to 30 percent pebbles.

Mesei Variant

The Mesei Variant consists of moderately deep, very poorly drained soils in closed depressional areas and basins on bottom lands and uplands. These soils formed in decaying plant material overlying hard basalt. Slope is 0 to 2 percent. The mean annual rainfall is 450 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Euic, isohyperthermic Typic Tropohemists.

Typical pedon: Mesei Variant mucky peat; in an area of marshland. When described (4/3/79), the soil was wet throughout. The water table was at the surface. Colors are for moist soil.

Oe1—0 to 17 centimeters; black (10YR 2/1) mucky peat; about 50 percent fiber, 20 percent rubbed; weak fine and medium subangular blocky structure; friable, nonsticky and nonplastic; many very fine roots and common medium roots; slightly acid (pH 6.4 in calcium chloride); clear smooth boundary.

Oe2—17 to 42 centimeters; black (5YR 2.5/1) mucky peat; about 60 percent fiber, 30 percent rubbed; weak medium and coarse subangular blocky structure; friable, nonsticky and nonplastic; common fine and medium roots; slightly acid (pH 6.4 in calcium chloride); clear wavy boundary.

Oe3—42 to 62 centimeters; dark reddish brown (5YR 3/2) mucky peat; about 80 percent fiber, 40 percent rubbed; moderate fine angular blocky structure; firm, nonsticky and nonplastic; common very fine and fine roots; medium acid (pH 6.0 in calcium chloride); abrupt smooth boundary.

R—62 centimeters; hard basalt.

Type location: Island of Ponape, Federated States of Micronesia, 25 meters south of the road across from the Ponape hospital and 25 meters east of the public works yard; lat. 6°57'13" N. and long. 158°13'31" east.

Range in characteristics: Depth to bedrock ranges from 50 to 75 centimeters. The profile is medium acid or slightly acid. It has color of 10YR 2/1, 2/2, or 3/2 or of 5YR 2/1 or 3/2. In some pedons a thin, very gravelly mucky silt loam or mucky silty clay loam horizon is between the lower organic horizon and bedrock.

Naniak series

The Naniak series consists of very deep, very poorly drained soils in coastal tidal marshes. These soils formed in alluvium derived from basic igneous rock. Slope is 0 to 2 percent. The mean annual rainfall is about 370 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Fine-loamy, mixed, nonacid, isohyperthermic Typic Sulfaquents.

Typical pedon: Naniak mucky silt loam; in an area of mangrove swamp forest. When described (7/15/79), the soil was wet throughout and the water table, because of the fluctuating tide, was at a depth of 15 centimeters. Colors are for moist soil. All textures are apparent field textures.

A11—0 to 15 centimeters; black (10YR 2/1) mucky silt loam; massive; nonsticky and nonplastic; few coarse and very coarse roots; common fine tubular pores; about 10 percent basalt pebbles; neutral (pH 6.7 in 1:1 water); gradual smooth boundary. (10 to 40 centimeters thick)

A12—15 to 30 centimeters; black (10YR 2/1) mucky silt loam; massive; nonsticky and nonplastic; few coarse and very coarse roots; common fine tubular pores; when gentle hand pressure is applied, the material escapes readily from between the fingers; slight odor of sulfur; about 5 percent basalt pebbles; slightly acid (pH 6.4 in 1:1 water); gradual smooth boundary. (0 to 30 centimeters thick)

AC—30 to 46 centimeters; black (10YR 2/1) mucky loam; massive; slightly sticky and nonplastic; few coarse roots; common fine tubular pores; when gentle hand pressure is applied, the material escapes readily from between the fingers; moderate odor of sulfur; about 5 percent basalt pebbles; slightly acid (pH 6.2 in 1:1 water); gradual smooth boundary. (5 to 20 centimeters thick)

C1—46 to 61 centimeters; very dark gray (10YR 3/1) mucky loam; massive; slightly sticky and nonplastic; when gentle hand pressure is applied, the material escapes readily from between the fingers; moderate odor of sulfur; about 10 percent basalt pebbles; slightly acid (pH 6.5 in 1:1 water); gradual smooth boundary. (10 to 50 centimeters thick)

IIC2—61 to 127 centimeters; black (5Y 2.5/1) gravelly loam; massive; slightly sticky and slightly plastic; strong odor of sulfur; about 25 percent basalt pebbles; slightly acid (pH 6.4 in 1:1 water); gradual smooth boundary. (0 to 100 centimeters thick)

IIC3—127 to 152 centimeters; black (5Y 2.5/2) very gravelly loam; massive; slightly sticky and slightly plastic; strong odor of sulfur; about 40 percent weathered basalt pebbles; slightly acid (pH 6.5 in 1:1 water).

Type location: Island of Ponape, Federated States of Micronesia; Kitti Municipality, Pehleng Village, about 47 meters northwest of the boathouse in the lot of Reikapw; lat. 6°52'3" N. and long. 158°9'8" E.

Range in characteristics: The depth to basalt or coral ranges from 100 to 150 centimeters or more. It is 8 to 15 percent organic carbon. The IIC horizon is as much as 40 percent pebbles.

Nansepsep series

The Nansepsep series consists of very deep, somewhat poorly drained soils on bottom lands. These soils formed in alluvium derived from basic igneous rock. Slope is 0 to 2 percent. The mean annual rainfall is about 450 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Fine, mixed, nonacid, isohyperthermic Aeric Tropaquepts.

Typical pedon: Nansepsep silt loam; in an area used for coconuts and bananas. When described (6/4/79), the soil was moist to a depth of 70 centimeters and saturated below that depth. Colors are for moist soil. All textures are apparent field textures.

A1—0 to 10 centimeters; dark brown (7.5YR 3/2) silt loam; moderate fine angular blocky structure; friable, slightly sticky and slightly plastic; common very fine, fine, and medium roots; common very fine and fine tubular and interstitial pores; medium acid (pH 5.6 in 1:1 water); abrupt wavy boundary. (8 to 20 centimeters thick)

B1—10 to 22 centimeters; dark brown (7.5YR 3/4) silt loam; moderate fine and medium subangular blocky structure; friable, slightly sticky and slightly plastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores; medium acid (pH 5.6 in 1:1 water); gradual wavy boundary. (8 to 25 centimeters thick)

B21—22 to 50 centimeters; dark grayish brown (2.5Y 4/2) silty clay loam; common fine distinct strong brown (7.5YR 4/6) mottles; moderate fine and medium angular blocky structure; friable, slightly sticky and slightly plastic; few very fine, fine, and medium roots; many very fine and fine tubular pores; medium acid (pH 6.0 in 1:1 water); abrupt wavy boundary. (20 to 45 centimeters thick)

B22—50 to 80 centimeters; dark grayish brown (2.5Y 4/2) silty clay loam; many fine distinct strong brown (7.5YR 4/6) mottles; moderate fine and very fine angular blocky structure; friable, sticky and plastic; few very fine and fine roots; common fine tubular pores; medium acid (pH 6.0 in 1:1 water); gradual wavy boundary. (20 to 50 centimeters thick)

B23—80 to 100 centimeters; dark grayish brown (2.5Y 4/2) silty clay loam; medium distinct strong brown (7.5YR 4/6) mottles; weak fine and medium angular blocky structure; friable, sticky and plastic; few very fine and fine roots; common fine tubular pores; slightly acid (pH 6.2 in 1:1 water); abrupt smooth boundary. (0 to 25 centimeters thick)

Cg—100 to 150 centimeters; dark greenish gray (5GY 4/1) silty clay loam; weak fine and medium angular blocky structure; friable, sticky and plastic; common very fine tubular pores; slightly acid (pH 6.2 in 1:1 water).

Type location: Island of Ponape, Federated States of Micronesia; 50 meters south of the second bridge of Alokapw and 15 meters west of the road in the municipality of Madolenihmw; lat. 6°55'5" N. and long. 158°17'46" E.

Range in characteristics: Depth to the fluctuating water table ranges from 50 to 75 centimeters. The soil is medium acid or slightly acid.

The A horizon has moist color of 10YR 3/2 or 3/3 or of 7.5YR 3/2. It is silt loam or silty clay loam and has 0 to 15 percent pebbles.

The B horizon has moist color of 10YR 4/2, 5/2, or 5/3, of 7.5YR 3/4 or 4/4, or of 2.5Y 4/2. It has mottles of 10YR 4/6 or of 7.5YR 4/6 or 5/6. It is silt loam, silty clay loam, or silty clay and has 0 to 15 percent pebbles.

The C horizon is gleyed silty clay or silty clay loam and is 0 to 25 percent basalt pebbles.

Ngedebus series

The Ngedebus series consists of very deep, somewhat excessively drained soils adjacent to coastal beaches and within interiors of atoll islands. These soils formed in water- and wind-deposited coral sand. Slope is 0 to 4 percent. The mean annual rainfall is about 370 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Carbonatic, isohyperthermic Typic Tropopsamments.

Typical pedon: Ngedebus sand; on a 2-percent, east-by-southeast-facing, convex slope in an area of casuarina forest. When described (10/30/79), the soil was moist throughout. Colors are for moist soil.

A1—0 to 46 centimeters; 50 percent grayish brown (10YR 5/2) sand mixed with 50 percent very pale brown (10YR 7/3) uncoated sand; single grain; loose; common very fine, fine, medium, and coarse roots; many very fine interstitial pores; mixed by land crabs to include lenses of pale yellow (2.5Y 8/4) sand; strongly effervescent; mildly alkaline (pH 7.7 in 1:1 water); clear wavy boundary. (10 to 50 centimeters thick)

C1—46 to 81 centimeters; pale yellow (2.5Y 8/4) sand; single grain; loose; many very fine interstitial pores; strongly effervescent; moderately alkaline (pH 7.9 in 1:1 water); clear smooth boundary. (35 to 100 centimeters thick)

C2—81 to 150 centimeters; very pale brown (10YR 8/4) coarse sand; single grain; loose; many very fine interstitial pores; about 4 percent coarse coral fragments 5 to 20 millimeters by 20 to 40 millimeters in size; freshwater table at a depth of 122 centimeters; strongly effervescent; moderately alkaline (pH 8.0 in 1:1 water).

Type location: Peleliu Municipality, Peleliu Island, Palau, Western Caroline Islands; about 1.25 kilometers north-northeast of Peleliu Village on main road and 1 kilometer south from the first road junction, then about 5 meters east of roadway; lat. 7°2'36" N. and long. 134°16'35" E.

Range in characteristics: Depth to the freshwater table ranges from 100 centimeters to more than 150 centimeters.

The A horizon has moist color of 10YR 2/1, 2/2, 3/1, 3/2, 3/3, 4/2, 4/3, 5/2, 5/3, or 7/3 or of 2.5Y 3/2. An AC horizon, present in some pedons, has moist color of 10YR 6/1, 6/2, or 7/2. It is sand, fine sand, or loamy sand and is gravelly in some pedons. The A horizon is 0 to 20 percent pebbles and 0 to 10 percent cobbles. Reaction in 1:1 water ranges from neutral to moderately alkaline.

The C horizon has moist color of 10YR, 7.5YR, or 2.5Y, value of 6 to 8, and chroma of 2 to 4. It is stratified fine sand, sand, or coarse sand and is gravelly in some pedons. Pebble content ranges from 0 to 25 percent. Cobble content ranges from 0 to 15 percent. Coarse fragment content averages less than 35 percent within the particle-size control section. Reaction in 1:1 water ranges from mildly alkaline to strongly alkaline.

Rakied series

The Rakied series consists of very deep, somewhat poorly drained soils on uplands and terraces. These soils formed in material derived from basaltic flows. Slope is 0 to 5 percent. The mean annual rainfall is 470 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Clayey-skeletal, oxidic, isohyperthermic Plinthic Acrorthox.

Typical pedon: Rakied extremely gravelly sandy loam; on a 2-percent slope in an area of agricultural forest. When described (1/15/79), the soil was moist throughout. Colors are for moist soil. All textures are apparent field textures.

A11—0 to 13 centimeters; very dark brown (10YR 2/2) extremely gravelly sandy loam; weak fine subangular blocky structure parting to moderate fine granular; very friable, nonsticky and slightly plastic; many fine and medium roots; many very fine and common fine interstitial pores; about 70 percent smooth ironstone concretions 2 to 20 millimeters in diameter and 10 percent vesicular gibbsite concretions; medium acid (pH 5.6 in 1:1 water); clear smooth boundary. (8 to 20 centimeters thick)

A12—13 to 41 centimeters; very dark brown (10YR 2/2) extremely gravelly sandy clay loam; weak medium subangular blocky structure parting to strong fine and medium granular; very friable, slightly sticky and slightly plastic; many fine and medium roots; common very fine tubular and interstitial pores and few fine tubular pores; 65 percent iron concretions and 15 percent vesicular gibbsite concretions; medium acid (pH 5.9 in 1:1 water); clear smooth boundary. (10 to 30 centimeters thick)

B21—41 to 51 centimeters; variegated brown (7.5YR 5/4) and red (2.5YR 4/6) very gravelly sandy clay loam; moderate medium subangular blocky structure parting to moderate fine and medium granular; friable, slightly sticky and slightly plastic; common fine and medium roots; common very fine and fine tubular and interstitial pores; 45 percent iron concretions, few gibbsite concretions, and few iron-coated conglomerate pebbles 5 to 8 centimeters in diameter; the red material has horizontally oriented bands; slightly acid (pH 6.1 in 1:1 water); abrupt clear boundary. (10 to 20 centimeters thick)

B22—51 to 91 centimeters; dark brown (7.5YR 4/4) very gravelly clay loam; many medium and large distinct red (10YR 4/6) mottles; weak medium and coarse subangular blocky structure parting to moderate very fine subangular blocky; firm, sticky and plastic; few very fine and fine roots concentrated on top of this horizon; common very fine and fine interstitial pores; few thin waxy coatings lining pores; about 50 percent ironstone concretions; few thin brittle iron-cemented sheets in the upper part of this horizon; slightly acid (pH 6.3 in 1:1 water); clear wavy boundary. (25 to 60 centimeters thick)

B23—91 to 122 centimeters; strong brown (7.5YR 4/6) very gravelly sandy clay loam; many medium distinct red (10R 4/8) mottles; weak coarse subangular blocky structure; firm, slightly sticky and slightly plastic; common very fine tubular pores; common thin waxy coatings lining pores; about 50 percent ironstone concretions 2 to 30 millimeters in diameter; slightly brittle when moist because of weak iron cementation; slightly acid (pH 6.4 in 1:1 water); abrupt wavy boundary. (0 to 50 centimeters thick)

C—122 to 152 centimeters; strong brown (7.5YR 5/6) very gravelly sandy clay loam; common medium distinct brownish yellow (10YR 6/6) mottles; massive; friable, slightly sticky and slightly plastic; common very fine tubular pores; about 60 percent ironstone and gibbsite concretions; slightly acid (pH 6.3 in 1:1 water).

Type location: Island of Ponape, Federated States of Micronesia; about 100 meters south of Panuelo's store and 30 meters west of main road; lat. 6°57'13.9" N. and long. 158°12'38" E.

Range in characteristics: Depth to a fluctuating water table ranges from about 50 to 120 centimeters. The profile in 1:1 water is medium acid or slightly acid.

The A horizon has moist color of 10YR 2/2, 4/2, or 3/3, of 7.5YR 3/2, or of 5YR 3/2. It is sandy loam or sandy clay loam and is 40 to 90 percent pebbles.

The B horizon has mottled color in hue of 10R, 2.5YR, 5YR, 7.5YR, or 10YR. Chroma and value range from 4 to 8. This horizon is sandy clay loam or clay loam and is 35 to 75 percent pebbles.

The C horizon has colors similar to those in the B horizon but is commonly a little browner. It is sandy clay loam, clay loam, clay, or sandy clay and is 35 to 75 percent pebbles and 0 to 20 percent cobbles.

Sonahnpil series

The Sonahnpil series consists of very deep, well drained soils on flood plains and alluvial fans. These soils formed in alluvium derived from basic igneous rock. Slope is 0 to 5 percent. The mean annual rainfall is about 470 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Clayey-skeletal, mixed, isohyperthermic Fluventic Dystropepts.

Typical pedon: Sonahnpil very stony silty clay loam; on a 1-percent slope in an area of agricultural forest. When described (7/30/79), the soil was moist throughout. Colors are for moist soil. All textures are apparent field textures.

O1—2 centimeters to 0; freshly fallen and partially decomposed organic litter. (1 to 5 centimeters thick)

A1—0 to 18 centimeters; very dark brown (10YR 2/2) very stony silty clay loam; moderate fine and medium granular structure; very friable, slightly sticky and slightly plastic; many fine and medium roots and few coarse roots; common fine and medium tubular and interstitial pores; about 20 percent rounded hard basalt stones, 10 percent cobbles, and 10 percent pebbles; very strongly acid (pH 4.6 in 1:1 water); abrupt smooth boundary. (10 to 25 centimeters thick)

B1—18 to 25 centimeters; dark brown (10YR 3/3) cobbly silty clay loam; moderate fine and medium subangular blocky structure; friable, slightly sticky and slightly plastic; common fine and medium roots and few coarse roots; common fine tubular pores; about 15 percent rounded hard basalt cobbles and 10 percent pebbles; very strongly acid (pH 5.0 in 1:1 water); abrupt wavy boundary. (5 to 10 centimeters thick)

B21—25 to 50 centimeters; dark brown (10YR 3/3) extremely stony sandy clay loam; weak medium subangular blocky structure; friable, slightly sticky and nonplastic; few medium roots; common fine and very fine interstitial and tubular pores; about 40 percent rounded hard basalt stones, 20 percent cobbles, and 20 percent rounded pebbles; very strongly acid (pH 4.8 in 1:1 water); clear wavy boundary. (20 to 30 centimeters thick)

B22—50 to 76 centimeters; dark yellowish brown (10YR 3/4) very stony sandy clay loam; weak fine and medium subangular blocky structure; friable, slightly sticky and nonplastic; few fine and coarse roots; common very fine interstitial pores; about 30 percent rounded hard basalt stones, 20 percent cobbles, and 20 percent pebbles; very strongly acid (pH 4.8 in 1:1 water); gradual wavy boundary. (20 to 30 centimeters thick)

C—76 to 150 centimeters; dark yellowish brown (10YR 4/4) very stony sandy clay loam; weak fine and medium subangular blocky structure; friable, slightly sticky and nonplastic; about 50 percent stones and cobbles and 20 percent pebbles; very strongly acid (pH 4.6 in 1:1 water).

Type location: Island of Ponape, Federated States of Micronesia; 16 meters south of the Mwelilap hanging bridge over the Nanpil River; lat. 6°55'55" N. and long. 158°13'22" E.

Range in characteristics: The profile in 1:1 water is very strongly acid or strongly acid.

The A horizon has moist color of 10YR 2/2 or 3/2 or of 7.5YR 3/2. It is silty clay loam, silt loam, or clay loam and is 10 to 40 percent stones and cobbles and 5 to 20 percent pebbles.

The B and C horizons have color of 10YR 3/3, 3/4, 4/4, or 4/6. They are silty clay loam, clay loam, or sandy clay loam and are 15 to 60 percent stones and cobbles and 10 to 25 percent pebbles.

Tolonier series

The Tolonier series consists of very deep, well drained soils on uplands. These soils formed in residuum and colluvium derived from basic igneous rock. Slope is 6 to 100 percent. The mean annual rainfall is about 370 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Clayey-skeletal, mixed, isohyperthermic Typic Dystropepts.

Typical pedon: Tolonier very stony clay loam; on a 50-percent, concave slope in an area of agricultural forest. When described (2/20/79), the soil was moist throughout. Colors are for moist soil. All textures are apparent field textures.

A11—0 to 10 centimeters; dark brown (10YR 3/3) very stony clay loam; strong fine and medium granular structure; friable, slightly sticky and slightly plastic; many fine and medium roots; many fine and medium tubular pores; about 20 percent hard basalt stones, 20 percent cobbles, and 10 percent pebbles; strongly acid (pH 5.2 in 1:1 water); abrupt wavy boundary. (8 to 15 centimeters thick)

A12—10 to 25 centimeters; dark brown (10YR 4/3) very stony silty clay loam; moderate fine subangular blocky structure parting to strong fine and medium granular; friable, slightly sticky and slightly plastic; many fine and medium roots; many fine and medium tubular pores; about 30 percent hard basalt stones, 15 percent cobbles, and 10 percent pebbles; strongly acid (pH 5.2 in 1:1 water); clear wavy boundary. (7 to 20 centimeters thick)

B1—25 to 45 centimeters; dark yellowish brown (10YR 4/4) stony clay loam; moderate medium subangular blocky structure parting to strong very fine angular blocky; firm, sticky and plastic; many fine and medium roots; many fine and medium tubular pores; common thin waxy coatings on faces of peds and in some pores; about 20 percent hard basalt stones and 10 percent cobbles; strongly acid (pH 5.2 in 1:1 water); clear wavy boundary. (0 to 25 centimeters thick)

B2—45 to 95 centimeters; dark brown (7.5YR 4/4) extremely stony silty clay; moderate medium subangular blocky structure parting to strong very fine angular blocky; firm, sticky and plastic; common fine and medium roots; many fine and medium tubular pores; common moderately thick waxy coatings on faces of peds and thin waxy coatings in some pores; about 40 percent hard basalt stones and 25 percent cobbles; strongly acid (pH 5.2 in 1:1 water); clear wavy boundary. (40 to 75 centimeters thick)

C1—95 to 125 centimeters; brown (10YR 5/4) extremely stony clay loam; weak medium and coarse subangular blocky structure; firm, sticky and plastic; few fine and medium roots; many fine and medium tubular pores; few thin waxy coatings on faces of peds; about 60 percent stones and cobbles and 10 percent pebbles; very strongly acid (pH 5.0 in 1:1 water); clear wavy boundary. (25 to 55 centimeters thick)

C2—125 to 180 centimeters; strong brown (7.5YR 5/6) extremely stony clay loam; weak medium and coarse subangular blocky structure; firm, sticky and plastic; few fine and medium roots; common very fine and few fine tubular pores; about 60 percent stones and cobbles and 10 percent pebbles; very strongly acid (pH 5.0 in 1:1 water).

Type location: Sokehs Island, Ponape, Federated States of Micronesia; about 1 kilometer up the old Japanese road on the east side of Sokehs Island, in a road cut; lat. 6°57'55" N. and long. 158°11'56" E.

Range in characteristics: The profile is 150 to 300 centimeters thick. Reaction in 1:1 water is very strongly acid to medium acid.

The A horizon has moist color of 10YR 3/3, 3/4, 4/2, or 4/3. It is silty clay loam, clay loam, or silty clay. It is 10 to 50 percent cobbles and stones and 0 to 15 percent pebbles.

The B horizon has color of 10YR 4/4 or 4/6 or of 7.5YR 4/4. It is clay loam, silty clay loam, or silty clay. The horizon is 25 to 65 percent stones and cobbles and 0 to 20 percent pebbles.

The C horizon has color of 7.5YR 4/6 or 5/6 or of 10YR 4/4, 4/6, or 5/4. It is clay loam or silty clay loam. The horizon is 30 to 70 percent stones and cobbles and 5 to 20 percent pebbles.

Umpump series

The Umpump series consists of moderately deep, moderately well drained soils on old basalt flows. These soils formed in residuum derived from basalt flows. Slope is 2 to 15 percent. The mean annual rainfall is about 470 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Clayey, oxidic, isohyperthermic, shallow Typic Acrorthox.

Typical pedon: Umpump gravelly silty clay loam; on an 8-percent simple slope in an area formerly cultivated. When described (1/2/79), the soil was moist throughout. Colors are for moist soil. All textures are apparent field textures.

Ap—0 to 13 centimeters; dark yellowish brown (10YR 4/4) gravelly silty clay loam; weak fine subangular blocky structure parting to moderate fine and medium granular; friable, slightly sticky and slightly plastic; many fine and medium roots; many very fine and fine interstitial pores and few medium tubular pores; about 25 percent angular to subrounded iron concretions and few vesicular gibbsite concretions; very strongly acid (pH 5.0 in 1:1 water); clear smooth boundary. (10 to 25 centimeters thick)

B1—13 to 41 centimeters; strong brown (7.5YR 4/6) gravelly silty clay loam; weak medium subangular blocky structure parting to strong fine and medium granular; firm, sticky and plastic; common fine roots; many very fine and fine tubular pores, few medium tubular pores, and few very fine and fine interstitial pores; about 20 percent subrounded iron concretions 2 to 10 millimeters in diameter; strongly acid (pH 5.1 in 1:1 water); abrupt wavy boundary. (13 to 30 centimeters thick)

B2—41 to 66 centimeters; red (2.5YR 4/6) gravelly silty clay; many fine and medium distinct strong brown (7.5YR 5/6) mottles; moderate fine and medium subangular blocky structure parting to strong fine and medium granular; firm, sticky and plastic; common fine roots in upper part decreasing to few in lower part; many very fine and fine tubular and interstitial pores; few thin waxy coatings lining pores; about 20 percent subrounded iron concretions and 5 percent platy gibbsite concretions; slightly acid (pH 6.1 in 1:1 water); abrupt irregular boundary. (25 to 50 centimeters thick)

Cr—66 centimeters; variegated dark brown (7.5YR 3/4) and red (2.5YR 4/6) highly weathered basic igneous rock; can be dug with spade; many fractures less than 1 millimeter wide running in random planes about 10 to 20 centimeters apart; common thin clay films and manganese precipitates coating fracture faces; medium acid (pH 5.9 in 1:1 water).

Type location: Island of Ponape, Federated States of Micronesia; 87 meters northwest of the south corner of the Ponape Agriculture Station, along the boundary fence, then 6 meters northeast of fence; lat. 6°57'18.6" N. and long. 158°12'50.7" E.

Range in characteristics: The depth to paralithic contact and the thickness of the solum range from 50 to 100 centimeters.

The A horizon generally has moist color of 7.5YR 3/4 or of 10YR 3/3, 3/4, or 4/4. In areas that have been repeatedly burned, the color is 10YR 2/1, 2/2, or 3/2. The horizon is silty clay loam, clay loam, or sandy clay loam and is 5 to 50 percent pebble-sized concretions. Reaction in 1:1 water is very strongly acid or strongly acid.

The upper part of the B horizon has moist color of 7.5YR 3/4, 4/4, or 4/6 or of 10YR 4/4, 4/6, or 5/8; the lower part is mottled with colors of 2.5YR 3/6 or 4/6, of 7.5YR 4/4, 4/6, or 5/6, or of 10YR 4/6 or 5/6. The horizon is silty clay loam, clay loam, sandy clay loam, or silty clay. It is 5 to 35 percent pebble-sized iron concretions. The reaction in 1:1 water ranges from strongly acid to slightly acid.

Wahrekdam series

The Wahrekdam series consists of moderately deep, well drained soils on uplands and ridgetops. These soils formed in residuum derived from basic igneous rock. Slope is 2 to 8 percent. The mean annual rainfall is about 370 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Clayey-skeletal, oxidic, isohyperthermic, shallow Plinthic Acrorthox.

Typical pedon: Wahrekdam very gravelly sandy loam; on a 2-percent slope in an area of agricultural forest. When described (1/24/79), the soil was moist throughout. Colors are for moist soil. All textures are apparent field textures.

A1—0 to 20 centimeters; dark brown (10YR 3/3) very gravelly sandy loam; moderate fine and medium granular structure; very friable, nonsticky and nonplastic; many fine and medium roots and common coarse roots; many very fine and fine interstitial pores; about 40 percent subrounded iron concretions 2 to 20 millimeters in diameter and about 10 percent small angular basalt cobbles; medium acid (pH 6.0 in 1:1 water); clear smooth boundary. (13 to 25 centimeters thick)

B1—20 to 43 centimeters; strong brown (7.5YR 5/6) very gravelly sandy clay loam; weak medium subangular blocky structure parting to moderate fine and medium granular; very friable, slightly sticky and slightly plastic; many fine and medium roots; common very fine and fine tubular pores and many very fine and fine interstitial pores; about 25 percent subrounded iron concretions 2 to 20 millimeters in diameter, 10 percent angular basalt pebbles, and 10 percent angular basalt cobbles; medium acid (pH 6.0 in 1:1 water); gradual wavy boundary. (13 to 25 centimeters thick)

B2—43 to 75 centimeters; strong brown (7.5YR 5/8) very cobbly clay loam; weak coarse subangular blocky structure parting to moderate fine and medium granular; friable, slightly sticky and slightly plastic; few fine and medium roots; common very fine and fine tubular pores; common thin waxy coatings on faces of peds and in pores; about 20 percent iron concretions and 30 percent weathered basalt cobbles; medium acid (pH 5.8 in 1:1 water); abrupt wavy boundary. (24 to 50 centimeters thick)

Cr—75 to 80 centimeters; yellowish red (5YR 4/6) platy weathering rind that crushes to silt loam; firm and brittle; abrupt wavy boundary. (2 to 10 centimeters thick)

R—80 centimeters; fractured hard basalt; fracture seams are 20 to 60 centimeters apart and 1 to 3 centimeters wide and are filled with black manganese precipitates and weathering rinds.

Type location: Island of Ponape, Federated States of Micronesia; about 100 meters north of water tank on paved road and 20 meters west of road, in Nett Municipality; lat. 6°56'50.7" N. and long. 158°13'20.3" E.

Range in characteristics: The thickness of the profile and of the solum ranges from 50 to 100 centimeters. The profile in 1:1 water is strongly acid or medium acid.

The A horizon has moist color of 10YR 3/2 or 3/3. It is sandy loam or sandy clay loam and is 15 to 50 percent pebbles and 0 to 20 percent cobbles.

The B horizon has moist color of 7.5YR 4/6, 5/6, or 5/8 or of 10YR 4/4 or 4/6. It is sandy clay loam, clay loam, or sandy clay. The horizon is 20 to 50 percent pebbles and 10 to 40 percent cobbles.

factors of soil formation

The interaction of five soil-forming factors—climate, plants and animals, relief, parent material, and time—determines the characteristics of a soil at any given point. Each of these factors affects the formation of every soil, and each modifies the effects of the other four. The relative effect of an individual factor varies from one soil to another. The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made about the effect of any one unless conditions are specified for the other four.

Climate and plants and animals are the active forces of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into soil. Relief modifies the effects of climate and vegetation, mainly by its influence on runoff, erosion, and temperature. The nature of the parent material also affects the kind of soil that is formed. Time is needed for changing the parent material into soil. Generally, a long time is needed for distinct soil horizons to form. The interactions among these factors are more complex for some soils than for others. The five factors of soil formation are briefly discussed in the following pages.

climate

The high rainfall and warm temperatures in the survey area have promoted the rapid weathering of parent material into soils. The warm climate is favorable for rapid chemical and physical reactions, for the decomposition or organic material from plants and animals, and for other soil-forming processes. Temperature and rainfall govern the rate of weathering of the rocks and the decomposition of minerals. They also influence leaching, eluviation, and illuviation. Most of the soils in the area have lost soluble bases and nutrients through leaching because of the high rainfall. The loss of bases lowers the soil reaction. The soils in the area generally are slightly acid to very strongly acid.

Climate has had a strong influence on the formation of most of the soils in the area, but it does not account for all the local differences among the soils. More information on climate is given in the introduction to the soil survey.

plants and animals

Plants, animals, fungi, and bacteria are important to soil formation. The changes they bring about depend mainly on the kinds of life processes peculiar to each.

The vegetation is generally responsible for the amount of organic matter in the soil, the color of the surface layer, and the amount of nutrients. Growing plants provide a cover that reduces erosion and helps to stabilize the surface so that the soil-forming processes can continue. Leaves, twigs, and entire plants accumulate on the surface of forest soils and then decompose as a result of percolating water and of micro-organisms, earthworms, and other forms of animal life acting on the soil. The roots of plants widen cracks in the rocks and thus permit more water to enter the soil. Also, the uprooting of trees influences soil formation by mixing the soil layers and loosening the underlying material.

Earthworms, ants, and many other burrowing animals are extremely active in the survey area. They help to keep the soil open and porous, mix the layers of the soil, mix organic matter into the soils, and help to break down the remains of plants. Earthworms and other small invertebrates feed on organic matter in the upper few centimeters of the soil. They slowly but continually mix the soil material and, in places, alter it chemically. Bacteria, fungi, and other micro-organisms hasten the weathering of rock minerals and the decay of organic matter. Man has affected the surface and subsurface layers of the soil in many areas by clearing and plowing the land, fertilizing, mixing horizons, and accelerating the rate of erosion.

relief

Relief influences soil formation through its effect on runoff, drainage, erosion, and vegetation. Runoff generally is rapid on mountainsides and slow on plains. In sloping areas where runoff is medium to very rapid, the soils generally are well drained, have a bright colored and unmottled subsoil, and are leached to a greater depth than the wetter soils in the same area. The Dolen and Tolonier soils are examples. In the more gently sloping areas, where runoff is slower, the soils generally are wet for a short period and have mottles in the subsoil. The Umpump and Rakied soils are examples. In level or slightly depressional areas, where the water table is at or near the surface for a long period, the soils display more evidence of wetness. For example, the Inkosr and Nansepsep soils are mottled in the upper part of the subsoil and gleyed in the lower part.

Very steep to extremely steep soils, such as the Fomseng soils, are shallow because of erosion. Soils on foot slopes and toe slopes and on alluvial fans, such as the Sonahnpil soils, formed in colluvial and alluvial material transported from the steeper areas and generally are very deep.

parent material

Parent material is the unconsolidated mass from which soils form. It largely determines the chemical and mineralogical composition of the soil. To a large extent, the minerals in the parent material determine the kinds and amounts of clay in the soil. Most of the soils in the area formed in material derived from basic igneous rock, mainly basalt, andesite, and trachyte lava flows and dikes (*6*). Basic igneous rock weathers to fine textured soils such as the Dolen and Dolekei soils. Among the other soils in the area, the Mesei Variant soils formed in organic deposits, the Ngedebus soils formed in coral sand and gravel, and the Naniak soils formed in mixed alluvial sediment and organic deposits. These soils are different from each other in morphology, use, and behavior. These differences are directly related to differences in parent material.

time

A long period of time generally is required for soils to form. The differences in the length of time that parent materials have been in place are commonly reflected in the characteristics of the soil.

The soils in this survey area range from young to old. The young soils exhibit little or no profile development, and the old soils have a profile that is well defined. Fomseng Variant soils are examples of young soils. They are young because the rate of soil erosion has nearly kept up with the rate of soil formation, leaving a shallow, young soil. Except for a darkening of the thin surface layer and a weakly developed subsoil, they retain most of the characteristics of their parent material. Rakied and Umpump soils are examples of old soils. They formed on a nearly level, stable land surface. They are acid and are low in content of extractable bases. Their thick, red subsoil and ironstone concretions indicate that they have been exposed to the soil-forming processes for a long period.

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glossary

Agricultural forest. A forest consisting of planted trees for producing food, such as bananas and breadfruit, mixed with other native non-food-producing trees.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as centimeters of water per centimeter of soil. The capacity, in centimeters, in a 150-centimeter profile or to a limiting layer is expressed as—

	Centi-meters
Very low	0 to 7.5
Low	7.5 to 15
Moderate	15 to 22.5
High	22.5 to 30
Very high	More than 30

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 60 centimeters in diameter.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters in diameter; if flat, mineral or rock particles (flagstone) 15.2 to 38.1 centimeters long.

Coarse textured soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 7.5 to 25 centimeters in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping (or contour farming). Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature; for example, fire that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

Excess salts (in tables). Excess water-soluble salts in the soil that restrict the growth of most plants.

Excess sulfur (in tables). Excessive amount of sulfur in the soil. The sulfur causes extreme acidity if the soil is drained, and the growth of most plants is restricted.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Fine textured soil. Sandy clay, silty clay, and clay.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 2 millimeters to 7.5 centimeters in diameter. An individual piece is a pebble.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual*. The major horizons of mineral soil are as follows:

O horizon.—An organic layer of fresh and decaying plant residue at the surface of a mineral soil.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.

Cr layer.—Weathered bedrock or saprolite, such as weathered igneous rock, that roots cannot enter except along fracture planes. The material can be dug with a spade.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intertropical convergence zone. The boundary area between the trade wind systems of the Northern Hemisphere and the Southern Hemisphere. It is an elongated band of disturbed weather that usually is broken rather than continuous. In the Pacific Ocean area, it generally is north of the equator in all seasons.

Large stones (in tables). Rock fragments 7.5 centimeters or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters; *medium*, from 5 to 15 millimeters; and *coarse*, more than 15 millimeters.

Muck. Dark colored, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Mulch. A protective covering of organic materials on the surface of the soil.

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture. (See Fibric soil material.)

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 1 square meter to 10 square meters, depending on the variability of the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.02 centimeter
Slow	0.02 to 0.5 centimeter
Moderately slow	0.5 to 1.5 centimeters
Moderate	1.5 to 5.0 centimeters
Moderately rapid	5.0 to 15.0 centimeters
Rapid	15.0 to 50 centimeters
Very rapid	more than 50 centimeters

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plinthite. The sesquioxide-rich, humus-poor, highly weathered mixture of clay with quartz and other diluents. It commonly appears as red mottles, usually in platy, polygonal, or reticulate patterns. Plinthite changes irreversibly to an ironstone hardpan or to irregular aggregates on repeated wetting and drying, especially if it is exposed also to heat from the sun. In a moist soil, plinthite can be cut with a spade. It is a form of laterite.

Ponding. Standing water on soils in closed depressions. The water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability or an impermeable layer near the surface, the soil may not adequately filter effluent from a waste disposal system.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Salty water (in tables.) Water that is too salty for consumption by livestock.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Saprolite (soil science). Unconsolidated residual material underlying the soil and grading to hard bedrock below.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Slippage (in tables). Soil mass susceptible to movement downslope when loaded, excavated, or wet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 6.1 meters in 30.5 meters of horizontal distance. In this survey the following slope classes are recognized:

	Percent
Nearly level	0 to 2
Gently sloping	2 to 6
Strongly sloping	6 to 12
Moderately steep	12 to 20
Steep	20 to 45
Very steep	45 to 60
Extremely steep	60 and higher

Slope (in tables). Slope is great enough that special practices are required to insure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Small stones (in tables). Rock fragments less than 7.5 centimeters in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Stones. Rock fragments 25 to 60 centimeters in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands that provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsidence. The settlement of organic soils, which results either from desiccation and shrinkage or oxidation of organic material, or both, following drainage.

Subsistence farming. Farm operations that provide barely the living requirements of the operator and his family rather than an excess for sale on the market.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 10 to 25 centimeters. Frequently designated as the "plow layer," or the "Ap horizon."

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but occurring in such a limited geographic area that creation of a new series is not justified.

Variegation. Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Water table. The upper limit of the soil or underlying rock that is wholly saturated with water.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

tables

TABLE 1.--HECTARAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Hectares	Percent
300	Dolekei-Fomseng association, 15 to 30 percent slopes	1,870	5.1
301	Dolekei-Fomseng association, 30 to 60 percent slopes	817	2.2
302	Dolekei-Fomseng association, 15 to 30 percent slopes, cobbly	2,367	6.5
303	Dolekei-Fomseng association, 30 to 60 percent slopes, cobbly	1,813	5.0
304	Dolen cobbly silty clay loam, 6 to 15 percent slopes	279	0.8
305	Dolen cobbly silty clay loam, 15 to 30 percent slopes	1,518	4.2
306	Fomseng-Dolekei association, 60 to 100 percent slopes	1,327	3.6
307	Fomseng Variant silt loam, 15 to 30 percent slopes	279	0.8
308	Fomseng Variant silt loam, 30 to 60 percent slopes	77	0.2
309	Inkosr gravelly sandy clay loam, 0 to 2 percent slopes	210	0.6
310	Mesei Variant mucky peat, 0 to 2 percent slopes	210	0.6
311	Naniak mucky silt loam, 0 to 2 percent slopes	5,010	13.7
312	Nansepsep silt loam, 0 to 2 percent slopes	595	1.6
313	Ngedebus-Rubble land association, 0 to 2 percent slopes	45	0.1
314	Rakied extremely gravelly sandy loam, 0 to 5 percent slopes	882	2.4
315	Rakied extremely gravelly sandy loam, 0 to 2 percent slopes, high water table	32	0.1
316	Rakied-Urban land complex, 0 to 5 percent slopes	81	0.2
317	Sonahnpil very stony silty clay loam, 0 to 5 percent slopes	607	1.7
318	Tolonier-Dolen association, 30 to 60 percent slopes	7,934	21.7
319	Tolonier-Dolen association, 60 to 100 percent slopes	6,151	16.9
320	Typic troporthents-Urban land complex, 0 to 1 percent slopes	109	0.3
321	Umpump silty clay loam, 2 to 8 percent slopes	1,384	3.8
322	Umpump gravelly sandy clay loam, 2 to 15 percent slopes	1,044	2.9
323	Umpump gravelly silty clay loam, 2 to 8 percent slopes	429	1.2
324	Umpump very gravelly clay loam, 2 to 8 percent slopes	720	2.0
325	Umpump-Urban land complex, 2 to 8 percent slopes	85	0.2
326	Wahrekdam very gravelly sandy loam, 2 to 8 percent slopes	587	1.6
	Total	36,462	100.0

TABLE 2.--SUITABILITY OF CROPS FOR SPECIFIED MAP UNITS

[A rating of 1 indicates that the crop is suited to the unit; 2, that the crop is suited if special management is used; and 3, that the crop is not suited. Map units not rated are not suited to any of the crops specified]

Crop	Map units																		
	300	301	302	303	304	305	309	310	312	313	314	315	317	318	321	322	323	324	326
Avocados	2	2	2	2	1	1	3	3	3	3	2	3	2	2	2	2	2	2	2
Bananas	2	2	2	2	1	1	3	3	2	2	2	3	2	2	2	2	2	2	2
Black pepper	2	3	2	3	1	1	3	3	3	3	2	3	3	2	2	2	2	2	2
Breadfruit	2	2	2	2	1	1	3	3	3	2	2	3	2	2	2	2	2	2	2
Chinese cabbage	3	3	3	3	2	2	3	3	2	3	2	3	3	3	2	2	2	2	2
Citrus fruit	2	2	2	2	1	1	3	3	3	3	2	3	2	2	2	2	2	2	2
Coconuts	2	2	2	2	1	1	3	3	2	1	2	2	2	2	2	2	2	2	2
Corn	3	3	3	3	2	2	3	3	3	3	2	3	3	3	2	2	2	2	2
Cucumbers	3	3	3	3	2	2	3	3	2	3	2	3	3	3	2	2	2	2	2
Green onions	3	3	3	3	2	2	3	3	2	3	2	3	3	3	2	2	2	2	2
Kava	2	2	2	2	1	1	3	3	3	3	2	3	3	2	2	2	2	2	2
Mangoes	2	2	2	2	1	1	3	3	3	3	2	3	2	2	2	2	2	2	2
Papayas	2	3	2	3	1	1	3	3	3	3	2	3	3	2	2	2	2	2	2
Pineapples	2	3	2	3	2	2	3	3	3	3	2	3	3	3	2	2	2	2	2
Rice	3	3	3	3	3	3	1	2	2	3	3	3	3	3	3	3	3	3	3
Sugarcane	2	3	2	3	1	2	3	3	3	3	2	3	3	3	2	2	2	2	2
Sweet potatoes	2	3	2	3	2	2	3	3	3	2	2	3	3	3	2	2	2	2	2
Tapioca	2	3	2	3	1	2	3	3	3	3	2	3	3	3	2	2	2	2	2
Taro, dryland	2	2	2	2	1	1	2	3	2	3	2	2	3	2	2	2	2	2	2
Taro, wetland	3	3	3	3	3	3	1	1	2	3	3	2	3	3	3	3	3	3	3
Vanilla	2	3	2	3	2	2	3	3	3	3	2	3	3	2	2	2	2	2	2
Watermelons	2	3	2	3	2	2	3	3	3	2	2	3	3	3	2	2	2	2	2
Yams	2	3	2	3	1	1	3	3	3	3	2	3	2	2	2	2	2	2	2

TABLE 3.--WOODLAND MANAGEMENT AND PRODUCTIVITY

[Only the soils suitable for production of commercial trees are listed. Only scientific names for trees are given in this table. Common names are listed in the section "Woodland management and productivity"]

Soil name and map symbol	Management concerns				Common trees	Trees to plant
	Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition		
300*, 302:						
Dolekei	Slight	Slight	Slight	Moderate	Campnosperma brevipetiolata, Adenanthera pavonina, Elaeocarpus carolinensis.	Eucalyptus saligna, Eucalyptus deglupta, Tectona grandis, Swietenia macrophylla.
301*, 303:						
Dolekei	Moderate	Slight	Slight	Moderate	Campnosperma brevipetiolata, Adenanthera pavonina, Elaeocarpus carolinensis.	Eucalyptus saligna, Eucalyptus deglupta, Tectona grandis, Swietenia macrophylla.
304 Dolen	Slight	Slight	Slight	Severe	Campnosperma brevipetiolata, Elaeocarpus carolinensis, Adenanthera pavonina, Parinarium glaberrium.	Campnosperma brevipetiolata, Adenanthera pavonina, Eucalyptus saligna, Eucalyptus deglupta, Tectona grandis, Swietenia macrophylla.
305 Dolen	Moderate	Slight	Slight	Severe	Campnosperma brevipetiolata, Elaeocarpus carolinensis, Adenanthera pavonina, Parinarium glaberrium.	Campnosperma brevipetiolata, Adenanthera pavonina, Eucalyptus saligna, Eucalyptus deglupta, Tectona grandis, Swietenia macrophylla.
311 Naniak	Severe	Moderate	Slight	Slight	Bruguiera gymnorhiza, Rhizophora apiculata, Rhizophora mucronata, Sonneratia alba, Xylocarpus granatum.	(**)
317 Sonahnpil	Severe	Moderate	Slight	Severe	Campnosperma brevipetiolata, Elaeocarpus carolinensis, Barringtonia racemosa.	Campnosperma brevipetiolata, Eucalyptus robusta, Eucalyptus saligna, Tectona grandis, Swietenia macrophylla.
318*:						
Tolonier	Moderate	Slight	Slight	Moderate	Campnosperma brevipetiolata, Elaeocarpus carolinensis, Adenanthera pavonina, Parinarium glaberrium.	Campnosperma brevipetiolata, Adenanthera pavonina, Eucalyptus saligna, Eucalyptus deglupta, Tectona grandis, Swietenia macrophylla.
Dolen	Moderate	Slight	Slight	Severe	Campnosperma brevipetiolata, Elaeocarpus carolinensis, Adenanthera pavonina, Parinarium glaberrium.	Campnosperma brevipetiolata, Adenanthera pavonina, Eucalyptus saligna, Eucalyptus deglupta, Tectona grandis, Swietenia macrophylla.

See footnotes at end of table.

TABLE 3.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Management concerns: Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition	Common trees	Trees to plant
321, 322, 323, 324--Umpump	Slight	Moderate	Slight	Moderate	Campnosperma brevipetiolata, Elaeocarpus carolinensis, Adenanthera pavonina, Parinarium glaberrium, Barringtonia racemosa.	Eucalyptus saligna, Eucalyptus deglupta, Tectona grandis, Swietenia macrophylla.
326-----------------Wahrekdam	Slight	Moderate	Moderate	Moderate	Campnosperma brevipetiolata, Elaeocarpus carolinensis, Parinarium glaberrium.	Eucalyptus saligna, Eucalyptus deglupta, Tectona grandis, Swietenia macrophylla.

* See description of the map unit for composition and behavior characteristics of the map unit.
** This soil is not suited to planting of trees. Only natural regeneration is practical.

TABLE 4.--COMMON NAMES FOR TREES

Scientific name	Ponapean common name	English common name
Adenanthera pavonina	kaikes	red sandalwood tree
Barringtonia racemosa	winmar	barringtonia
Bruguiera gymnorhiza	sohmw	oriental mangrove
Campnosperma brevipetiolata	dong	campnosperma
Elaeocarpus carolinensis	satak	blue marble
Eucalyptus deglupta	none	deglupta eucalyptus
Eucalyptus robusta	none	robusta eucalyptus
Eucalyptus saligna	none	saligna eucalyptus
Parinarium glaberrium	ais	parinarium
Rhizophora apiculata	aakapah	mangrove
Rhizophora mucronata	aakalel	rhizophora
Sonneratia alba	koatoa	sonneratia
Swietenia macrophylla	none	Honduras mahogany
Tectona grandis	none	teak
Xylocarpus granatum	pwulok	xylocarpus

TABLE 5.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
300*:					
Dolekei	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Fomseng	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope, small stones, depth to rock.	Severe: slope.	Severe: slope, thin layer.
301*:					
Dolekei	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Fomseng	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope, small stones, depth to rock.	Severe: slope.	Severe: slope, thin layer.
302*:					
Dolekei	Severe: slope.	Severe: slope.	Severe: large stones, small stones.	Severe: slope.	Severe: slope.
Fomseng	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe:e: slope.	Severe: slope, thin layer.
303*:					
Dolekei	Severe: slope.	Severe: slope.	Severe: large stones, small stones.	Severe: slope.	Severe: slope.
Fomseng	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope.	Severe: slope, thin layer.
304 Dolen	Moderate: large stones, slope.	Moderate: large stones, slope.	Severe: large stones, slope.	Moderate: large stones.	Severe: large stones.
305 Dolen	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: large stones, slope.
306*:					
Fomseng	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope.	Severe: slope, thin layer.
Dolekei	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: large stones,
307 Fomseng Variant	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope.	Severe: slope, thin layer.
308 Fomseng Variant	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope.	Severe: slope, thin layer.
309 Inkosr	Severe: flooding, wetness.	Severe: wetness.	Severe: small stones, wetness.	Severe: wetness.	Severe: wetness.

See footnote at end of table.

TABLE 5.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
310------------------- Mesei Variant	Severe: flooding, excess humus.	Severe: excess humus.	Severe: excess humus, flooding.	Severe: excess humus.	Severe: flooding, excess humus.
311------------------- Naniak	Severe: flooding, ponding, excess humus.	Severe: ponding, excess humus, excess salt.	Severe: excess humus, ponding, flooding.	Severe: ponding, excess humus.	Severe: excess salt, excess sulfur, ponding.
312------------------- Nansepsep	Severe: flooding.	Moderate: wetness.	Moderate: wetness, flooding.	Moderate: wetness.	Moderate: wetness, flooding.
313*:					
Ngedebus-------------	Severe: flooding, too sandy.	Severe: too sandy.	Moderate: small stones, flooding.	Severe: too sandy.	Moderate: droughty, flooding.
Rubble land.					
314, 315-------------- Rakied	Severe: small stones.	Severe: small stones.	Severe: small stones.	Severe: small stones.	Severe: small stones.
316*:					
Rakied---------------	Severe: small stones.	Severe: small stones.	Severe: small stones.	Severe: small stones.	Severe: small stones.
Urban land.					
317------------------- Sonahnpil	Severe: flooding.	Moderate: large stones, small stones.	Severe: large stones, small stones.	Severe: large stones.	Severe: large stones.
318*, 319*:					
Tolonier-------------	Severe: slope.	Severe: slope.	Severe: large stones, small stones.	Severe: large stones.	Severe: large stones, slope.
Dolen----------------	Severe: slope.	Severe: slope.	Severe: large stones.	Severe: slope.	Severe: slope.
320*:					
Typic troporthents.					
Urban land.					
321------------------- Umpump	Moderate: wetness.	Moderate: wetness.	Moderate: slope, small stones, wetness.	Slight------------	Moderate: thin layer.
322------------------- Umpump	Moderate: slope, small stones, wetness.	Moderate: slope, wetness, small stones.	Severe: slope, small stones.	Slight------------	Moderate: small stones, slope.
323------------------- Umpump	Moderate: small stones, wetness.	Moderate: wetness, small stones.	Severe: small stones.	Slight------------	Moderate: small stones, thin layer.
324------------------- Umpump	Severe: small stones.	Severe: small stones.	Severe: small stones.	Slight------------	Severe: small stones.
325*:					
Umpump---------------	Moderate: small stones, wetness.	Moderate: wetness, small stones.	Severe: small stones.	Slight------------	Moderate: small stones, thin layer.

See footnote at end of table.

TABLE 5.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
325*: Urban land.					
326-------------------- Wahrekdam	Severe: small stones.	Severe: small stones.	Severe: small stones.	Moderate: small stones.	Severe: small stones.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 6.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
300*, 301*:					
Dolekei	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Fomseng	Severe: depth to rock, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, thin layer.
302*, 303*:					
Dolekei	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Fomseng	Severe: depth to rock, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, thin layer.
304 Dolen	Moderate: large stones, slope.	Moderate: slope.	Severe: slope.	Severe: low strength.	Severe: large stones.
305 Dolen	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: large stones, slope.
306*:					
Fomseng	Severe: depth to rock, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, thin layer.
Dolekei	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
307, 308 Fomseng Variant	Severe: depth to rock, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, thin layer.
309 Inkosr	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: wetness, flooding.	Severe: wetness.
310 Mesei Variant	Severe: depth to rock, excess humus.	Severe: flooding, low strength.	Severe: flooding, low strength.	Severe: low strength, wetness.	Severe: flooding, excess humus.
311 Naniak	Severe: excess humus, ponding.	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: low strength, ponding, flooding.	Severe: excess salt, excess sulfur, ponding.
312 Nansepsep	Severe: wetness.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Moderate: wetness, flooding.
313*:					
Ngedebus	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Moderate: flooding.	Moderate: droughty, flooding.
Rubble land.					

See footnote at end of table.

TABLE 6.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
314 Rakied	Moderate: wetness.	Slight	Slight	Slight	Severe: small stones.
315 Rakied	Severe: wetness.	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Severe: small stones.
316*:					
Rakied	Moderate: wetness.	Slight	Slight	Slight	Severe: small stones.
Urban land.					
317 Sonahnpil	Severe: large stones.	Severe: flooding, large stones.	Severe: flooding, large stones.	Severe: flooding, large stones.	Severe: large stones.
318*, 319*:					
Tolonier	Severe: large stones.	Severe: large stones.	Severe: large stones.	Severe: slope, large stones.	Severe: large stones.
Dolen	Moderate: large stones.	Moderate: large stones.	Moderate: large stones.	Severe: low strength, slope.	Severe: large stones.
320*:					
Typic Troporthents.					
Urban land.					
321 Umpump	Severe: wetness.	Moderate: wetness.	Moderate: wetness, slope.	Moderate: wetness.	Moderate: thin layer.
322 Umpump	Severe: wetness.	Moderate: wetness, slope.	Severe: slope.	Moderate: wetness, slope.	Moderate: small stones, slope.
323 Umpump	Severe: wetness.	Moderate: wetness.	Moderate: wetness, slope.	Moderate: wetness.	Moderate: small stones, thin layer.
324 Umpump	Severe: wetness.	Moderate: wetness.	Moderate: wetness, slope.	Moderate: wetness.	Severe: small stones.
325*:					
Umpump	Severe: wetness.	Moderate: wetness.	Moderate: wetness, slope.	Moderate: wetness.	Moderate: small stones, thin layer.
Urban land.					
326 Wahrekdam	Severe: depth to rock.	Moderate: depth to rock, large stones.	Moderate: slope, depth to rock, large stones.	Moderate: depth to rock, large stones.	Severe: small stones.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
300*, 301*, 302*, 303*:					
Dolekei	Severe: depth to rock, slope.	Severe: seepage, depth to rock.	Severe: depth to rock, seepage, too clayey.	Severe: depth to rock, seepage, slope.	Poor: area reclaim, too clayey, large stones.
Fomseng	Severe: depth to rock, slope.	Severe: seepage, depth to rock, slope.	Severe: depth to rock, seepage, slope.	Severe: depth to rock, seepage, slope.	Poor: area reclaim, hard to pack, slope.
304 Dolen	Moderate: large stones, slope.	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: hard to pack.
305 Dolen	Severe: slope.	Severe: seepage.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: hard to pack, slope.
306*:					
Fomseng	Severe: depth to rock, slope.	Severe: seepage, depth to rock, slope.	Severe: depth to rock, seepage, slope.	Severe: depth to rock, seepage, slope.	Poor: area reclaim, hard to pack, slope.
Dolekei	Severe: depth to rock, slope.	Severe: seepage, depth to rock.	Severe: depth to rock, seepage, too clayey.	Severe: depth to rock, seepage, slope.	Poor: area reclaim, too clayey, large stones.
307, 308 Fomseng Variant	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Poor: area reclaim, slope.
309 Inkosr	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: hard to pack, wetness.
310 Mesei Variant	Severe: flooding, depth to rock.	Severe: seepage, depth to rock, flooding.	Severe: flooding, depth to rock, seepage.	Severe: flooding, depth to rock, seepage.	Poor: area reclaim, excess humus.
311 Naniak	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: flooding, ponding, excess salt.	Severe: flooding, ponding.	Poor: hard to pack, small stones, ponding.
312 Nansepsep	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack.
313*:					
Ngedebus	Severe: flooding, wetness, poor filter.	Severe: seepage, flooding.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage.	Poor: seepage, too sandy, small stones.
Rubble land.					
314, 315 Rakied	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Poor: seepage, small stones.

See footnote at end of table.

TABLE 7.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
316*:					
Rakied	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Poor: seepage, small stones.
Urban land.					
317 Sonahnpil	Severe: flooding, large stones.	Severe: seepage, flooding, large stones.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage.	Poor: hard to pack, large stones.
318*, 319*:					
Tolonier	Severe: large stones, slope.	Severe: seepage, large stones.	Severe: seepage, too clayey, large stones.	Severe: seepage, slope.	Poor: too clayey, hard to pack, large stones.
Dolen	Severe: slope.	Severe: seepage.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: hard to pack, slope.
320*:					
Typic Troporthents.					
Urban land.					
321 Umpump	Severe: depth to rock, wetness.	Severe: depth to rock, wetness.	Severe: depth to rock, wetness, too clayey.	Severe: depth to rock, wetness.	Poor: area reclaim, too clayey, small stones.
322 Umpump	Severe: depth to rock, wetness.	Severe: depth to rock, slope, wetness.	Severe: depth to rock, wetness, too clayey.	Severe: depth to rock, wetness.	Poor: area reclaim, too clayey, small stones.
323, 324 Umpump	Severe: depth to rock, wetness.	Severe: depth to rock, wetness.	Severe: depth to rock, wetness, too clayey.	Severe: depth to rock, wetness.	Poor: area reclaim, too clayey, small stones.
325*:					
Umpump	Severe: depth to rock, wetness.	Severe: depth to rock, wetness.	Severe: depth to rock, wetness, too clayey.	Severe: depth to rock, wetness.	Poor: area reclaim, too clayey, small stones.
Urban land.					
326 Wahrekdam	Severe: depth to rock.	Severe: seepage, depth to rock.	Severe: depth to rock, seepage, large stones.	Severe: depth to rock, seepage.	Poor: area reclaim, small stones.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," "probable," and "improbable." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
300*:				
Dolekei	Poor: area reclaim, thin layer.	Improbable: excess fines.	Improbable: excess fines.	Poor: large stones, slope.
Fomseng	Poor: area reclaim, thin layer, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, large stones, slope.
301*:				
Dolekei	Poor: area reclaim, thin layer, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: large stones, slope.
Fomseng	Poor: area reclaim, thin layer, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, large stones, slope.
302*:				
Dolekei	Poor: area reclaim, thin layer.	Improbable: excess fines.	Improbable: excess fines.	Poor: large stones, slope.
Fomseng	Poor: area reclaim, thin layer, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, large stones, slope.
303*:				
Dolekei	Poor: area reclaim, thin layer, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: large stones, slope.
Fomseng	Poor: area reclaim, thin layer, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, large stones, slope.
304 Dolen	Fair: low strength, large stones.	Improbable: excess fines.	Improbable: excess fines.	Poor: large stones, area reclaim.
305 Dolen	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope, large stones.
306*:				
Fomseng	Poor: area reclaim, thin layer, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, large stones, slope.
Dolekei	Poor: area reclaim, thin layer, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: large stones, slope.

See footnote at end of table.

TABLE 8.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
307: Fomseng Variant	Poor: area reclaim, thin layer, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, slope.
308: Fomseng Variant	Poor: area reclaim, thin layer, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, slope.
309: Inkosr	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, wetness.
310: Mesei Variant	Poor: area reclaim, low strength, thin layer.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus.
311: Naniak	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, area reclaim, excess salt.
312: Nansepsep	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
313*:				
Ngedebus	Good	Probable	Probable	Poor: too sandy, small stones, area reclaim.
Rubble land.				
314, 315: Rakied	Fair: wetness.	Improbable: small stones.	Probable	Poor: small stones, area reclaim.
316*:				
Rakied	Fair: wetness.	Improbable: small stones.	Probable	Poor: small stones, area reclaim.
Urban land.				
317: Sonahnpil	Poor: large stones.	Improbable: excess fines, large stones.	Improbable: excess fines, large stones.	Poor: large stones, area reclaim.
318*, 319*:				
Tolonier	Poor: large stones, slope.	Improbable: excess fines, large stones.	Improbable: excess fines, large stones.	Poor: large stones, area reclaim.
Dolen	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: large stones, area reclaim.
320*:				
Typic Troporthents.				
Urban land.				
321, 322, 323, 324: Umpump	Poor: thin layer.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.

See footnote at end of table.

TABLE 8.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
325*:				
Umpump	Poor: thin layer.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
Urban land.				
326 Wahrekdam	Poor: area reclaim, thin layer.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "moderate" and "severe." Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Limitations for-- Pond reservoir areas	Limitations for-- Embankments, dikes, and levees	Features affecting-- Drainage	Features affecting-- Terraces and diversions	Features affecting-- Grassed waterways
300*, 301*, 302*, 303*:					
Dolekei	Severe: seepage, slope.	Severe: thin layer.	Deep to water	Large stones, depth to rock, slope.	Large stones, depth to rock, slope.
Fomseng	Severe: depth to rock, slope.	Severe: hard to pack.	Deep to water	Slope, large stones, depth to rock.	Large stones, slope, depth to rock.
304, 305 Dolen	Severe: seepage, slope.	Severe: hard to pack.	Deep to water	Large stones, slope.	Large stones, slope.
306*:					
Fomseng	Severe: depth to rock, slope.	Severe: hard to pack.	Deep to water	Slope, large stones, depth to rock.	Large stones, slope, depth to rock.
Dolekei	Severe: seepage, slope.	Severe: thin layer.	Deep to water	Large stones, depth to rock, slope.	Large stones, depth to rock, slope.
307, 308 Fomseng Variant	Severe: depth to rock, slope.	Severe: thin layer.	Deep to water	Slope, depth to rock.	Slope, depth to rock.
309 Inkosr	Moderate: seepage.	Severe: hard to pack, wetness.	Flooding	Wetness	Wetness.
310 Mesei Variant	Severe: seepage.	Severe: excess humus.	Deep to water	Depth to rock	Depth to rock.
311 Naniak	Moderate: seepage.	Severe: hard to pack, ponding, excess salt.	Ponding, flooding, excess salt.	Ponding	Wetness, excess salt.
312 Nansepsep	Moderate: seepage.	Severe: hard to pack, wetness.	Flooding	Wetness	Favorable.
313*:					
Ngedebus	Severe: seepage.	Severe: seepage, piping.	Deep to water	Large stones, too sandy, soil blowing.	Large stones, droughty.
Rubble land.					
314 Rakied	Severe: seepage.	Severe: seepage.	Favorable	Wetness	Droughty.
315 Rakied	Severe: seepage.	Severe: seepage, wetness.	Favorable	Wetness	Droughty.
316*:					
Rakied	Severe: seepage.	Severe: seepage.	Favorable	Wetness	Droughty.
Urban land.					

See footnote at end of table.

TABLE 9.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Terraces and diversions	Grassed waterways
317: Sonahnpil	Severe: seepage.	Severe: hard to pack, large stones.	Deep to water	Large stones	Large stones, droughty.
318*, 319*:					
Tolonier	Severe: seepage.	Severe: hard to pack, large stones.	Deep to water	Large stones	Large stones, droughty.
Dolen	Severe: seepage.	Severe: hard to pack.	Deep to water	Large stones	Large stones.
320*:					
Typic Troporthents.					
Urban land.					
321: Umpump	Moderate: seepage, depth to rock, slope.	Severe: thin layer.	Depth to rock, slope.	Depth to rock, wetness.	Depth to rock.
322: Umpump	Severe: slope.	Severe: thin layer.	Depth to rock, slope.	Slope, depth to rock, wetness.	Slope, depth to rock.
323, 324: Umpump	Moderate: seepage, depth to rock, slope.	Severe: thin layer.	Depth to rock, slope.	Depth to rock, wetness.	Depth to rock.
325*:					
Umpump	Moderate: seepage, depth to rock, slope.	Severe: thin layer.	Depth to rock, slope.	Depth to rock, wetness.	Depth to rock.
Urban land.					
326: Wahrekdam	Severe: seepage.	Severe: large stones.	Deep to water	Large stones, depth to rock.	Large stones, depth to rock.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--ENGINEERING INDEX PROPERTIES

[The symbol > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Unified classification	Frag- ments > 76 mm	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plas- ticity index
	Cm			Pct					Pct	
300*:										
Dolekei----------	0-8	Silty clay loam	MH-O	0-10	95-100	90-100	85-100	75-95	50-60	10-20
	8-74	Silty clay loam, silty clay, cobbly silty clay loam.	MH-O	0-30	75-100	70-95	70-95	65-90	50-60	10-20
	74	Weathered bedrock	---	---	---	---	---	---	---	---
Fomseng----------	0-8	Clay loam	MH	0-5	80-95	75-90	65-80	60-80	50-60	10-20
	8-36	Silty clay, clay loam, cobbly clay loam.	MH	0-30	85-100	80-100	75-100	65-95	50-60	10-20
	36	Weathered bedrock	---	---	---	---	---	---	---	---
301*:										
Dolekei----------	0-8	Silty clay loam	MH-O	0-10	95-100	90-100	85-100	75-95	50-60	10-20
	8-74	Silty clay loam, silty clay, cobbly silty clay loam.	MH-O	0-30	75-100	70-95	70-95	65-90	50-60	10-20
	74	Weathered bedrock	---	---	---	---	---	---	---	---
Fomseng----------	0-8	Clay loam	MH	0-5	80-95	75-90	65-80	60-80	50-60	10-20
	8-36	Silty clay, clay loam, cobbly clay loam.	MH	0-30	85-100	80-100	75-100	65-95	50-60	10-20
	36	Weathered bedrock	---	---	---	---	---	---	---	---
302*, 303*:										
Dolekei----------	0-8	Cobbly silty clay loam.	MH-O	20-30	75-100	70-95	70-95	65-90	50-60	10-20
	8-74	Silty clay loam, silty clay, cobbly silty clay loam.	MH-O	0-30	75-100	70-95	70-95	65-90	50-60	10-20
	74	Weathered bedrock	---	---	---	---	---	---	---	---
Fomseng----------	0-8	Cobbly clay loam	MH	20-30	80-95	80-95	75-95	60-80	50-60	10-20
	8-36	Silty clay, clay loam, cobbly clay loam.	MH	0-30	85-100	80-100	75-100	65-95	50-60	10-20
	36	Weathered bedrock	---	---	---	---	---	---	---	---
304, 305---------- Dolen	0-5	Cobbly silty clay loam.	MH	15-35	95-100	90-100	85-95	75-90	50-65	10-20
	5-117	Silty clay loam, cobbly silty clay loam.	MH	0-30	95-100	90-100	85-95	75-95	50-65	10-20
	117-241	Stony silty clay loam, silty clay loam.	MH	0-35	80-100	75-100	70-100	65-95	50-65	10-20
306*:										
Fomseng----------	0-8	Clay loam----------	MH	0-15	95-100	90-100	80-100	65-80	50-60	10-20
	8-36	Silty clay, clay loam, cobbly clay loam.	MH	0-30	85-100	80-100	75-100	65-95	50-60	10-20
	36	Weathered bedrock	---	---	---	---	---	---	---	---

See footnote at end of table.

TABLE 10.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Unified classification	Frag- ments > 76 mm	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plas- ticity index
	Cm			Pct					Pct	
306*:										
Dolekei----------	0-8	Silty clay loam	MH-O	0-10	95-100	90-100	85-100	75-95	50-60	10-20
	8-74	Silty clay loam, silty clay, cobbly silty clay loam.	MH-O	0-30	75-100	70-95	70-95	65-90	50-60	10-20
	74	Weathered bedrock	---	---	---	---	---	---	---	---
307, 308---------- Fomseng Variant	0-10	Silt loam---------	MH	0-5	90-100	85-100	75-100	60-90	50-60	10-20
	10-17	Silty clay loam, clay loam.	MH	0-5	80-95	75-95	75-95	65-90	50-60	10-20
	17	Weathered bedrock	---	---	---	---	---	---	---	---
309--------------- Inkosr	0-10	Gravelly sandy clay loam.	MH, SC	0	60-85	55-80	50-65	25-50	60-70	10-20
	10-35	Silty clay loam, gravelly sandy clay loam, clay loam.	MH	5-10	60-100	55-100	50-100	25-95	60-70	10-20
	35-150	Silty clay loam, gravelly silty clay loam, clay.	MH	5-10	60-100	55-100	55-100	50-95	60-70	10-20
310--------------- Mesei Variant	0-62	Mucky-peat--------	PT	0	---	---	---	---	---	NP
	62	Unweathered bedrock.	---	---	---	---	---	---	---	---
311--------------- Naniak	0-30	Mucky silt loam	MH, OH	0-5	90-100	85-100	75-100	60-90	70-100	NP-5
	30-61	Mucky loam, mucky silt loam.	MH, OH	0-5	90-100	85-100	75-100	60-90	70-100	NP-5
	61-152	Gravelly loam, loam, silt loam.	MH, GM	0-5	55-100	50-100	45-100	35-85	65-75	5-10
312--------------- Nansepsep	0-10	Silt loam---------	MH	0	80-100	75-100	65-100	50-95	60-70	10-20
	10-100	Silt loam, silty clay loam, silty clay.	MH	0	80-100	75-100	65-100	50-95	60-70	10-20
	100-150	Silty clay loam, gravelly silty clay loam, silty clay.	MH	0-5	65-100	60-100	55-100	50-95	60-70	10-20
313*:										
Ngedebus---------	0-13	Fine sand---------	SM	0-5	85-100	80-100	45-80	15-30	---	NP
	13-150	Stratified sand to gravelly sand.	SP-SM, SM	0-25	70-100	65-100	30-80	5-35	---	NP
Rubble land.										
314--------------- Rakied	0-13	Extremely gravelly sandy loam.	GP, GP-GM	0-5	10-30	5-25	5-20	0-10	40-50	NP-5
	13-122	Very gravelly sandy clay loam, very gravelly clay loam, extremely gravelly sandy clay loam.	GM, GP-GM	10-15	20-55	15-50	10-45	5-30	50-60	10-20
	122-152	Very gravelly sandy clay loam, very gravelly sandy clay, extremely gravelly sand.	GM, GP-GM	0-30	20-55	15-50	10-40	5-30	50-60	10-20

See footnote at end of table.

TABLE 10.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Unified classification	Fragments > 76 mm	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	Cm			Pct					Pct	
315-------------- Rakied	0-13	Extremely gravelly sandy loam.	GP-GM	10-5	10-30	5-25	5-20	0-10	40-50	NP-5
	13-122	Very gravelly sandy clay loam, very gravelly clay loam, extremely gravelly sandy.	GM, GP-GM	10-15	20-55	15-50	10-45	5-30	50-60	10-20
	122-152	Very gravelly sandy clay loam, very gravelly sandy clay, extremely gravelly sand.	GM, GP-GM	10-30	20-55	15-50	10-40	5-30	50-60	10-20
316*: Rakied----------	0-13	Extremely gravelly sandy loam.	GP, GP-GM	10-15	10-30	5-25	5-20	0-10	40-50	NP-5
	13-122	Very gravelly sandy clay loam, very gravelly clay loam, extremely gravelly sandy.	GM, GP-GM	10-15	20-55	15-50	10-45	5-30	50-60	10-20
	122-152	Very gravelly sandy clay loam, very gravelly sandy clay, extremely gravelly sand.	GM, GP-GM	10-30	20-55	15-50	10-40	5-30	50-60	10-20
Urban land.										
317-------------- Sonahnpil	0-18	Very stony silty clay loam.	MH, GM	15-55	55-95	50-90	45-90	40-85	60-70	10-20
	18-150	Stratified cobbly sandy clay loam to extremely stony silty clay loam.	MH, GM, GP-GM	35-75	30-80	25-75	20-75	10-70	60-70	10-20
318*, 319*: Tolonier--------	0-25	Very stony clay loam.	MH	15-65	75-100	70-100	65-95	50-80	50-60	10-20
	25-95	Very stony silty clay loam, very stony clay loam, extremely stony silty clay.	MH	35-75	65-90	60-85	55-85	50-80	50-70	15-25
	95-180	Extremely stony clay loam, extremely stony silty clay loam, very stony clay loam.	MH	45-80	65-95	60-90	55-90	50-80	50-70	15-25
Dolen-----------	0-5	Cobbly silt loam	MH	15-35	95-100	90-100	85-95	75-90	50-65	10-20
	5-117	Silty clay loam, cobbly silty clay loam.	MH	0-30	95-100	90-100	85-95	75-95	50-65	10-20
	117-200	Stony silty clay loam, silty clay loam.	MH	0-35	80-100	75-100	70-100	65-95	50-65	10-20
320*: Typic Troporthents.										
Urban land.										

See footnote at end of table.

TABLE 10.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Unified classification	Frag- ments > 76 mm	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plas- ticity index
	Cm			Pct					Pct	
321--------------- Umpump	0-13	Silty clay loam	MH-O	0	85-95	80-95	75-95	65-90	50-60	10-20
	13-70	Silty clay loam, gravelly silty clay loam, gravelly silty clay.	MH-O, GM	0-5	55-95	50-95	45-95	40-90	50-60	10-20
	70	Weathered bedrock	---	---	---	---	---	---	---	---
322--------------- Umpump	0-13	Gravelly sandy clay loam.	MH-O, GM	0	55-80	50-75	40-75	20-70	50-60	10-20
	13-66	Silty clay loam, gravelly silty clay loam, gravelly silty clay.	MH-O, GM	0-5	55-95	50-95	45-95	40-90	50-60	10-20
	66	Weathered bedrock	---	---	---	---	---	---	---	---
323--------------- Umpump	0-13	Gravelly silty clay loam.	MH-O, GM	0	55-80	50-75	40-75	20-70	50-60	10-20
	13-66	Silty clay loam, gravelly silty clay loam, gravelly silty clay.	MH-O, GM	0-5	55-95	50-95	45-95	40-90	50-60	10-20
	66	Weathered bedrock	---	---	---	---	---	---	---	---
324--------------- Umpump	0-13	Very gravelly clay loam.	GM	0-5	40-55	35-50	30-45	25-40	50-60	10-20
	13-66	Silty clay loam, gravelly silty clay loam, gravelly silty clay.	MH-O, GM	0-5	55-95	50-95	45-95	40-90	50-60	10-20
	66	Weathered bedrock	---	---	---	---	---	---	---	---
325*:										
Umpump-----------	0-13	Gravelly silty clay loam.	MH-O, GM	0	55-80	50-75	40-75	20-70	50-60	10-20
	13-66	Silty clay loam, gravelly silty clay loam, gravelly silty clay.	MH-O, GM	0-5	55-95	50-95	45-95	40-90	50-60	10-20
	66	Weathered bedrock	---	---	---	---	---	---	---	---
Urban land.										
326--------------- Wahrekdam	0-20	Very gravelly sandy loam.	GM, SM	0-30	40-65	35-65	25-50	15-30	40-50	NP-5
	20-43	Very gravelly sandy clay loam, very gravelly clay loam, cobbly sandy clay loam.	GM, SM	10-30	40-75	35-75	25-65	15-40	50-60	10-20
	43-80	Very cobbly clay loam, very cobbly sandy clay loam, extremely cobbly clay loam.	GM, SM	25-55	25-65	25-65	25-65	25-65	50-60	10-20
	80	Unweathered bedrock.	---	---	---	---	---	---	---	---

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Moist bulk density	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Organic matter
	Cm	G/cm^3	Cm/hr	Cm/cm	pH	Mmhos/cm				Pct
300*, 301*:										
Dolekei----------	0-8	0.90-1.10	5.0-15	0.18-0.20	4.5-6.0	<2	Low----------	0.10	3	4-8
	8-74	1.00-1.20	5.0-15	0.15-0.20	4.5-6.0	<2	Low----------	0.10		
	74	---	---	---	---	---	-------------	----		
Fomseng----------	0-8	0.90-1.10	5.0-15	0.15-0.17	5.1-6.5	<2	Low----------	0.10	2	3-5
	8-36	1.00-1.20	5.0-15	0.17-0.20	5.1-6.0	<2	Low----------	0.10		
	36	---	---	---	---	---	-------------	----		
302*, 303*:										
Dolekei----------	0-8	0.90-1.10	5.0-15	0.15-0.18	4.5-6.0	<2	Low----------	0.10	3	4-8
	8-74	1.00-1.20	5.0-15	0.15-0.20	4.5-6.0	<2	Low----------	0.10		
	74	---	---	---	---	---	-------------	----		
Fomseng----------	0-8	0.90-1.10	5.0-15	0.15-0.17	5.1-6.5	<2	Low----------	0.10	2	3-5
	8-36	1.00-1.20	5.0-15	0.17-0.20	5.1-6.0	<2	Low----------	0.10		
	36	---	---	---	---	---	-------------	----		
304, 305---------- Dolen	0-5	1.00-1.20	5.0-15	0.14-0.16	5.1-6.5	<2	Low----------	0.10	5	4-7
	5-117	1.10-1.30	5.0-15	0.14-0.20	5.1-6.0	<2	Low----------	0.10		
	117-241	1.10-1.30	5.0-15	0.14-0.20	5.1-6.0	<2	Low----------	0.10		
306*:										
Fomseng----------	0-8	0.90-1.10	5.0-15	0.18-0.20	5.1-6.5	<2	Low----------	0.10	2	3-5
	8-36	1.00-1.20	5.0-15	0.17-0.20	5.1-6.0	<2	Low----------	0.10		
	36	---	---	---	---	---	-------------	----		
Dolekei----------	0-8	0.90-1.10	5.0-15	0.18-0.20	4.5-6.0	<2	Low----------	0.10	3	4-8
	8-74	1.00-1.20	5.0-15	0.15-0.20	4.5-6.0	<2	Low----------	0.10		
	74	---	---	---	---	---	-------------	----		
307, 308---------- Fomseng Variant	0-10	1.00-1.20	1.5-5.0	0.15-0.18	4.5-5.5	<2	Low----------	0.10	1	3-5
	10-17	1.00-1.20	1.5-5.0	0.15-0.18	4.5-5.5	<2	Low----------	0.15		
	7	---	---	---	---	---	-------------	----		
309--------------- Inkosr	0-10	1.20-1.30	1.5-5.0	0.11-0.13	5.1-6.0	<2	Low----------	0.10	5	4-7
	10-35	1.15-1.30	1.5-5.0	0.15-0.18	5.1-6.0	<2	Low----------	0.15		
	35-150	1.15-1.30	1.5-5.0	0.15-0.18	5.1-6.0	<2	Low----------	0.15		
310--------------- Mesei Variant	0-62	0.30-0.60	15-50	0.20-0.30	5.6-6.5	<2	Low----------	0.02	2	>80
	62	---	---	---	---	---	-------------	----		
311--------------- Naniak	0-30	0.60-0.90	1.5-5.0	0.20-0.24	6.1-7.3	>16	Low----------	0.05	5	10-20
	30-61	0.60-0.90	1.5-5.0	0.20-0.24	6.1-7.3	>16	Low----------	0.05		
	61-152	0.90-1.10	1.5-5.0	0.15-0.18	6.1-7.3	>16	Low----------	0.10		
312--------------- Nansepsep	0-10	1.00-1.20	1.5-5.0	0.14-0.16	5.6-6.5	<2	Low----------	0.10	5	4-7
	10-100	1.10-1.30	1.5-5.0	0.15-0.18	5.6-6.5	<2	Low----------	0.10		
	100-150	1.10-1.30	1.5-5.0	0.15-0.18	5.6-6.5	<2	Low----------	0.10		
313*:										
Ngedebus---------	0-13	1.20-1.40	15-50	0.08-0.10	6.6-8.4	<2	Low----------	0.10	5	1-3
	13-150	1.50-1.70	15-50	0.04-0.07	7.4-9.0	<2	Low----------	0.10		
Rubble land.										
314, 315---------- Rakied	0-13	1.10-1.30	5.0-15	0.05-0.07	5.6-6.5	<2	Low----------	0.05	5	3-5
	13-122	1.10-1.30	5.0-15	0.07-0.11	5.6-6.5	<2	Low----------	0.10		
	122-152	1.30-1.50	0.5-1.5	0.07-0.11	5.6-6.5	<2	Low----------	0.10		

See footnote at end of table.

TABLE 11.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Moist bulk density	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Organic matter
	Cm	G/cm3	Cm/hr	Cm/cm	pH	Mmhos/cm				Pct
316*:										
Rakied----------	0-13	1.10-1.30	5.0-15	0.05-0.07	5.6-6.5	<2	Low---------	0.05	5	3-5
	13-122	1.10-1.30	5.0-15	0.07-0.11	5.6-6.5	<2	Low---------	0.10		
	122-152	1.30-1.50	0.5-1.5	0.07-0.11	5.6-6.5	<2	Low---------	0.10		
Urban land.										
317--------------- Sonahnpil	0-18	1.10-1.30	5.0-15	0.10-0.15	4.5-5.5	<2	Low---------	0.10	5	4-7
	18-150	1.20-1.40	5.0-15	0.07-0.12	4.5-5.5	<2	Low---------	0.05		
318*, 319*:										
Tolonier--------	0-25	1.00-1.20	5.0-15	0.10-0.15	4.5-6.0	<2	Low---------	0.05	5	5-7
	25-95	1.10-1.30	5.0-15	0.10-0.14	4.5-6.0	<2	Low---------	0.25		
	95-180	1.10-1.30	5.0-15	0.09-0.13	4.5-6.0	<2	Low---------	0.25		
Dolen-----------	0-5	1.00-1.20	5.0-15	0.14-0.16	5.1-6.5	<2	Low---------	0.10	5	4-7
	5-117	1.10-1.30	5.0-15	0.14-0.20	5.1-6.0	<2	Low---------	0.10		
	117-200	1.10-1.30	5.0-15	0.14-0.20	5.1-6.0	<2	Low---------	0.10		
320*:										
Typic Troporthents.										
Urban land.										
321--------------- Umpump	0-13	1.00-1.20	5.0-15	0.15-0.18	4.5-5.5	<2	Low---------	0.15	3	4-6
	13-70	1.10-1.30	1.5-5.0	0.12-0.16	5.1-6.5	<2	Low---------	0.10		
	70	---	---	---	---	---	------------	----		
322, 323--------- Umpump	0-13	1.00-1.20	5.0-15	0.12-0.16	4.5-5.5	<2	Low---------	0.10	3	3-5
	13-66	1.10-1.30	1.5-5.0	0.12-0.16	5.1-6.5	<2	Low---------	0.10		
	66	---	---	---	---	---	------------	----		
324--------------- Umpump	0-13	1.00-1.20	5.0-15	0.10-0.14	4.5-5.5	<2	Low---------	0.10	3	2-4
	13-66	1.10-1.30	1.5-5.0	0.12-0.16	5.1-6.5	<2	Low---------	0.10		
	66	---	---	---	---	---	------------	----		
325*:										
Umpump----------	0-13	1.00-1.20	5.0-15	0.12-0.16	4.5-5.5	<2	Low---------	0.10	3	3-5
	13-66	1.10-1.30	1.5-5.0	0.12-0.16	5.1-6.5	<2	Low---------	0.10		
	66	---	---	---	---	---	------------	----		
Urban land.										
326--------------- Wahrekdam	0-20	1.10-1.30	5.0-15	0.10-0.13	5.1-6.0	<2	Low---------	0.10	2	3-6
	20-43	1.10-1.30	5.0-15	0.10-0.13	5.1-6.0	<2	Low---------	0.10		
	43-80	1.10-1.30	5.0-15	0.10-0.13	5.1-6.0	<2	Low---------	0.10		
	80	---	---	---	---	---	------------	----		

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--SOIL AND WATER FEATURES

["Flooding" and "water table" and terms such as "brief" are explained in the text. The symbol > means more than. Absence of an entry indicates that the feature is not a concern]

Soil name and map symbol	Hydrologic group	Flooding			High water table		Bedrock		Subsidence		Risk of corrosion	
		Frequency	Duration	Months	Depth	Months	Depth	Hardness	Initial	Total	Uncoated steel	Concrete
					Cm		Cm		Cm	Cm		
300*, 301*, 302*, 303*:												
Dolekei	B	None	---	---	>180	---	50-100	Soft	---	---	High	High.
Fomseng	C	None	---	---	>180	---	25-50	Soft	---	---	Moderate	Moderate.
304, 305 Dolen	B	None	---	---	>180	---	>150	---	---	---	Moderate	Moderate.
306*:												
Fomseng	C	None	---	---	>180	---	25-50	Soft	---	---	Moderate	Moderate.
Dolekei	B	None	---	---	>180	---	50-100	Soft	---	---	High	High.
307, 308 Fomseng Variant	C	None	---	---	>180	---	10-25	Soft	---	---	High	High.
309 Inkosr	D	Occasional	Brief	Jan-Dec	15-60	Jan-Dec	>180	---	---	---	Moderate	Moderate.
310 Mesei Variant	D	Frequent	Long	Jan-Dec	0-15	Jan-Dec	50-75	Hard	10-15	50-75	Moderate	Moderate.
311 Naniak	D	Frequent	Long	Jan-Dec	+30-30	Jan-Dec	>100	---	---	---	High	High.
312 Nansepsep	C	Occasional	Very brief	Jan-Dec	50-75	Jan-Dec	>150	---	---	---	Moderate	Moderate.
313*:												
Ngedebus	A	Occasional	Very brief	Jan-Dec	>100	Jan-Dec	>150	---	---	---	High	Low.
Rubble land.												
314 Rakied	C	None	---	---	50-120	Jan-Dec	>150	---	---	---	Moderate	Moderate.
315 Rakied	C	None	---	---	50-80	Jan-Dec	>150	---	---	---	Moderate	Moderate.
316*:												
Rakied	C	None	---	---	50-120	Jan-Dec	>150	---	---	---	Moderate	Moderate.
Urban land.												
317 Sonahnpil	B	Occasional	Very brief	Jan-Dec	150-180	Jan-Dec	>150	---	---	---	High	High.
318*, 319*:												
Tolonier	B	None	---	---	>180	---	>150	---	---	---	Moderate	Moderate.

See footnote at end of table.

TABLE 12.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding: Frequency	Flooding: Duration	Flooding: Months	High water table: Depth	High water table: Months	Bedrock: Depth	Bedrock: Hardness	Subsidence: Initial	Subsidence: Total	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete
					Cm		Cm		Cm	Cm		
318*, 319*:												
Dolen------------	B	None--------	---	---	>180	---	>150	---	---	---	Moderate	Moderate.
320*:												
Typic troporthents.												
Urban land.												
321, 322, 323, 324-------------- Umpump	B	None--------	---	---	60-100	Jan-Dec	50-100	Soft	---	---	High-----	High.
325*:												
Umpump-----------	B	None--------	---	---	60-100	Jan-Dec	50-100	Soft	---	---	High-----	High.
Urban land.												
326--------------- Wahrekdam	C	None--------	---	---	>180	---	50-100	Hard	---	---	Moderate	Moderate.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Dolekei	Fine, mixed, isohyperthermic Typic Dystropepts
Dolen	Very fine, mixed, isohyperthermic Typic Dystropepts
Fomseng	Clayey, mixed, isohyperthermic, shallow Typic Humitropepts
Fomseng Variant	Clayey, mixed, acid, isohyperthermic, shallow Typic Troporthents
Inkosr	Fine, mixed, nonacid, isohyperthermic Typic Tropaquepts
Mesei Variant	Euic, isohyperthermic Typic Tropohemists
Naniak	Fine-loamy, mixed, nonacid, isohyperthermic Typic Sulfaquents
Nansepsep	Fine, mixed, nonacid, isohyperthermic Aeric Tropaquepts
Ngedebus	Carbonatic, isohyperthermic Typic Tropopsamments
Rakied	Clayey-skeletal, oxidic, isohyperthermic Plinthic Acrorthox
Sonahnpil	Clayey-skeletal, mixed, isohyperthermic Fluventic Dystropepts
Tolonier	Clayey-skeletal, mixed, isohyperthermic Typic Dystropepts
Umpump	Clayey, oxidic, isohyperthermic, shallow Typic Acrorthox
Wahrekdam	Clayey-skeletal, oxidic, isohyperthermic, shallow Plinthic Acrorthox

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